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THE MARINE ALGÆ OF DENMARK

CONTRIBUTIONS TO THEIR NATURAL HISTORY

PART I

INTRODUCTION. RHODOPHYCEÆ I. (BANGIALES AND NEMALIONALES)

BY

L. KOLDERUP ROSENVINGE

WITH TWO CHARTS AND TWO PLATES

D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, 7. RÆKKE, NATURVIDENSK. OG MATH. AFD., VII. 1.



KØBENHAVN

HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL

BIANCO LUNOS BOGTRYKKERI

1909

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THE MARINE ALGÆ OF DENMARK

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VOL. I

RHODOPHYCÆ

BY

L. KOLDERUP ROSENVINGE

WITH TWO CHARTS AND EIGHT PLATES

D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, 7. RÆKKE, NATURVIDENSK. OG MATH. AFD., VII. 1—4



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PREFACE.

The study of the marine Algæ engaged my interest at an early period. Originally certain morphological, cytological and physiological questions were the objects of my studies, but later the plan to procure a general view of the Algæ found in the Danish waters gradually developed. In 1890 I began to make systematic collections in the Danish waters and continued during the following years, especially in 1891—95, when I became able to make extensive dredgings in all the Danish waters inside Skagen (Kattegat to Baltic) by means of official support during 4 years (from "Kommunitetet") and permission from the ministry to sail with the fishery control-steamers S. S. "Havørnen" and S. S. "Falken" and the fishery inspection-ship, the gunboat "Hauch". During the following years I have as occasion offered continued these collections partly onboard the Biological Station's S. S. "Sallingsund", especially on a cruise round Bornholm in 1901, the life-saving steamer S. S. "Vesterhavet" and the lightship transport S. S. "Nordsøen" in 1905 in the North Sea, the deep-sea research-ship S. S. "Thor" in the Skagerak, Kattegat and the Sound in 1907, a former revenue-cutter "Ragna" in private possession in 1904—1906 and partly in fishing boats, especially at different places on the north-western coast of Jutland.

The reason why my work has extended over such a long period is chiefly, that different works regarding Greenland's flora, vegetation and marine Algæ, have during a series of years taken up so much of my time that until 1898 I was mostly obliged to content myself with collecting material, while the working up of this could not begin until after that time. Another cause of the slow progress of the work is the abundance of the material collected, and lastly the scope of my work was gradually somewhat enlarged. From the beginning the aim of my investigations was, not only to state what species are found in the Danish waters, but to elucidate their extension here and also their variation and if possible their dependence on the external conditions. While working with the single species my investigations came more and more to have to do with morphology and the developmental history, and I saw how desirable it would be for the task I had undertaken if I could contribute as much as possible to the elucidation of the natural history of the separate species on the whole in Danish waters; I have also expressed this in the title of my work. I feel quite well, that I have not given

nearly so much as I could have wished in this direction, and I am by no means blind to the defects in my work just in this respect. But it is also quite clear to me, that if I do not wish to postpone the publication of my work until an uncertain future period, thus running the risk of never getting it finished, I must have it published, even if my investigations are not complete on many points.

On account of the extent of the work I have decided to have it published in small portions, to begin with the Rhodophyceæ. Of this family the well-known specialist, the conservator Mr. M. FOSLIE, several years ago undertook to determine the *Melobesiæ* and Mag. sc. Mr. HENNING E. PETERSEN undertook to work up the genus *Ceramium*. Mr. FOSLIE has already given the preliminary results of his work in several publications, but they will be dealt with in more detail in the present memoir. Mr. PETERSEN's work on the genus *Ceramium* was really destined to be embodied as a part of the same, but as it was finished before mine and was of considerable extent it was preferred to have it published separately¹.

Besides the two mentioned groups of red Algæ a large portion of the blue-green Algæ I have collected was worked up by Dr. JOHS. SCHMIDT in 1899². It may also be mentioned here, that mainly on the basis of my own collections and investigations I have been able to enumerate not a small number of species, which have not been known before in the Danish waters, in my work on the Algæ in ROSTRUP's Guide to the Danish flora³.

My thanks are due to many persons, who during the many years that have passed since I began my investigations have rendered me valuable assistance in different ways. I would here mention especially the different captains, the late fisheries supervisor Mr. A. BLOCH, Commander P. GROVE, the former fisheries supervisor Mr. HOLSTEIN, the present fisheries supervisor Mr. W. LARSEN, Captain ROSENKILDE, the retired Captain C. TROLLE; further the director of the Danish Biological Station Dr. C. G. JOH. PETERSEN and Dr. JOHS. SCHMIDT; also Dr. F. BØRGESSEN, Dr. TH. MORTENSEN, Dr. C. H. OSTENFELD, Mag. A. OTTERSTRØM, Mag. OVE PAULSEN and Mag. HENN. PETERSEN, who have placed their collections of Danish marine Algæ at my disposal.

I desire here also to express my best thanks to the Directors of the Carlsberg Fund for the assistance they have given to defray various expenses in connection with the publication of this work, especially the charts and photographs of plants.

¹ HENNING E. PETERSEN, Danske Arter af Slægten *Ceramium* (Roth) LYNGBYE. K. D. Vidensk. Selsk. Skr. 7. R. 5. B. No. 2 1908.

² JOHS. SCHMIDT, Danmarks blaagrønne Alger (*Cyanophyceae Daniae*) I. Hormogoneae. Botanisk Tidsskrift Bd. 22.

³ E. ROSTRUP, Vejledning i den danske Flora. Anden Del. Blomsterløse Planter. København 1904.

INTRODUCTION.

Earlier sources of our knowledge of Denmark's marine Algæ.

When on searching for the oldest statements in the literature on the Danish marine Algæ, we come upon OEDER's *Enumeratio plantarum Floræ Danicæ*¹, we might expect to find important information there, as the work deals specially with the "*Cryptantheræ*" i. e. the cryptogams. A considerable number of species of the genera *Conferva*, *Ulva* and *Fucus* are certainly mentioned there, but these are not known to occur inside the boundaries of the Danish kingdom. As the author, according to his own statement, had not studied the lower plants very closely, he contents himself with giving a good many North-European species, which he supposes might be found here. This paper therefore does not contain any more information about the Danish marine Algæ than that found in "Flora Danica", to which work reference is made for all the species figured there. OEDER has certainly mentioned not a small number of species in this monumental pictorial work, which began to appear in 1761, but they are almost all from Norway and Iceland or without indication of the locality. Only two species are noted from Denmark, namely Tab. 166, *Fucus siliquosus* (1763) [*Halidrys siliquosus* (L.) Lgb.] and Tab. 393, *Fucus fastigiatus* (1768) [*Furcellaria fastigiata* (Huds.) Lamx.].

In the parts of the same work edited by O. FR. MÜLLER (1775—1782) only a few marine Algæ from Denmark were mentioned (Tab. 763, *Ulva prolifera* [*Enteromorpha prolifera* (Müll.) J. Ag.]; Tab. 771, 2, *Conferva Linum* [*Chaetomorpha Linum* (Müll.) Kütz.]; Tab. 821, *Fucus Filum* [*Chorda Filum* (L.) Stackh.]; Tab. 882 *Conferva flexuosa* [*Cladophora* sp.]; Tab. 889, *Ulva Linza* [*Enteromorpha Linza* (L.) J. Ag.]), and none at all in the parts edited by MARTIN VAHL. At the end of the 18th century information was thus present about only a very small number of species of marine Algæ found on the coasts of Denmark.

In 1803 SCHUMACHER³ gives 26 species of Algæ from the coast of Sealand. A considerable proportion of these are however so insufficiently described that

¹ G. C. OEDER, *Enumeratio plantarum Floræ Danicæ. Cryptantheræ. Hafniæ* 1770.

² *Icones Floræ Danicæ. Hafniæ* 1761—1883 (Edit.: OEDER, O. F. MÜLLER, M. VAHL, HORNE-MANN, LIEBMAN, JOH. LANGE).

³ C. F. SCHUMACHER, *Enumeratio plantarum in partibus Sællandiæ septentrionalis et orientalis. Pars posterior, Hafniæ* 1803.

they cannot be identified. Besides three species formerly known as Danish, the following may be mentioned: *Enteromorpha intestinalis* (L.) Link (*Conferva int.* Schum.), *Cladophora rupestris* (L.) Kütz. (*Conferva rup.* Schum.), *Chordaria flagelliformis* (Müll.) Ag. (*Ceramium longissimum* Schum.), *Ahnfeltia plicata* (Huds.) Fr. (*Ceram. plicatum* Schum.), *Fucus serratus* (L.), *Fucus vesiculosus* L. and *Rivularia atra* Roth (*Linckia hemisphaerica* Schum.). Further LYNGBYE believed that he was able to identify *Elachista fucicola* (Vell.) Fr. (*Conferva ferruginea* Schum.) and *Chondrus crispus* (L.) Lgb. (*Fucus ceranoides* Schum.)¹.

No further information on Denmark's marine Algæ appears in the 2nd edition of HORNE-MANN'S "Plantelære"² published 3 years later. Only 11 species, all referred to the genus *Fucus*, are noted, but not a single one is expressly mentioned as found in Denmark.

It was only in the 2nd decade of the 19th century that a more exact study of the Algæ was begun in this country, first by N. HOFMAN BANG, the owner of Hofmansgave on the north coast of Fyen, and at his instigation also by H. C. LYNGBYE, private tutor at Hofmansgave from 1812—1817. The publisher at that time of Flora Danica, HORNE-MANN, who was in close connection with these two investigators of Algæ, included in this work during the years 1813—1818 25 species of marine Algæ from Denmark, mostly until then unknown in its flora; the number of the species was by this addition more than doubled, but a decisive change was not accomplished until the publication of LYNGBYE'S hydrophytology³. This work was originally written in 1817 as an essay to which the University had awarded a prize in the previous year, but it was enlarged so much later that the Algæ from Holstein, the Færoes, Iceland, Greenland and also partly from Norway all came to be included in it. On the whole 323 species are mentioned here, for Denmark about 100 species with 12 varieties of marine Algæ; Denmark thus rose at once to the level of the countries, in which the algal flora was relatively well investigated. This work holds a good place as one of the main works among the earlier descriptive phycologies by reason of its careful descriptions of species and its numerous good figures. With regard to Denmark it is essentially based upon numerous collections by HOFMAN BANG and by LYNGBYE at Hofmansgave and upon studies of the latter at the same place, in less measure upon collections in the Sound, while other localities are very incompletely represented. Consequently it deals relatively exhaustively with the algal flora of the north coast of Fyen, while it gives very little

¹ Among these species *Ceramium cartilagineum* (l. c. p. 112) must also be mentioned. LYNGBYE who had the opportunity to examine SCHUMACHER'S specimen, found between Amager and Sjælland, discovered that it really belonged to *Fucus cartilagineus* Turner (= *Gelidium cartilagineum* (Turn.) Gaill.) a species, the native place of which is at the Cape of Good Hope, and he found that, in regard to the epiphytic animals it also agreed with samples of this species from that place, consequently he was right in concluding that it in some way, e. g. by a ship, had been transported from its original, far-off home (LYNGBYE Hydr. p. 56).

² J. W. HORNE-MANN, Forsøg til en dansk oekonomisk Plantelære. Kjøbenhavn 1806.

³ H. C. LYNGBYE, Tentamen Hydrophytologiæ Danicæ. Hafniæ 1819.

information about the distribution of the species within the Danish area. As LYNGBYE's work will be cited in the following pages when dealing with the single species, its importance to the knowledge of the Danish marine algal flora need not be more closely explained here.

During the following years several Danish marine Algæ were included in the parts of Flora Danica published by HORNE-MANN, without anything essentially new being given in addition to what is found in LYNGBYE's work.

A greater increase in the number of Danish species appears in the 3rd edition of HORNE-MANN's "Plantelære"¹, the number here reaching 127. The real increase was however far from being so great. Thus, two of the species mentioned belong to the animal kingdom (*Alcyonidium diaphanum* and *flavescens*); some seem to have been included by mistake as found in Denmark, as they have not been discovered here by others and no Danish specimens are known (*Sphærococcus ciliatus*, *S. lacinatus*, *Zonaria dichotoma*). Several of the new species are scarcely sufficiently distinct from others found earlier, e. g. several *Hutchinsia*-species, *Vaucheria litorea* Ag. (*V. clavata* Lgb.) etc. But even after these reductions, a number of real additions remain of which the most important are:

<i>Calothrix fasciculata</i> Ag.	<i>Halymenia palmata</i> Ag. (<i>Rhodymenia palmata</i>)
<i>Rivularia pellucida</i> Ag.	
<i>Bryopsis plumosa</i> Ag.	<i>Rhodomela dentata</i> Ag. (<i>Odonthalia dentata</i> Lgb.)
<i>Ectocarpus tomentosus</i> Ag.	
<i>Zonaria deusta</i> Ag. (<i>Ralfsia verrucosa</i>)	<i>Callithamnion roseum</i> Ag.
<i>Chordaria divaricata</i> Ag.	<i>Ptilota plumosa</i> Ag. (<i>Plumaria elegans</i>)
<i>Bangia atropurpurea</i> Ag. (<i>B. fuscopurpurea</i>)	<i>Halymenia edulis</i> Ag. (<i>Dilsea edulis</i>)

Two years later LIEBMAN² made some new additions to the Danish marine algal flora. A great part of these species were however not really new in the flora; thus his *Laminaria latifolia* is only a form of *L. saccharina*, *Asperococcus echinatus* = *Scytosiphon Lomentaria*, *Punctaria cæspitosa* = *Phyllitis Fascia*, *Sphacelaria cæspitula* not identical with LYNGBYE's species of that name but perhaps only small specimens of *Sphacelaria cirrosa*, *Polysiphonia lepadicola* = *P. urceolata*. — New to the flora are however at all events *Callithamnion pyramidatum* Liebm. = *C. fruticosum* J. Ag. and *Lyngbya lutescens* Liebm. = *L. lutea* (Ag.) Gom., and probably *Ptilota plumosa*. His *Dictyota dichotoma* is also new, but however, as the specimens prove, is *Taonia atomaria*; but this Atlantic species cannot have grown on the coasts of Denmark, but must probably have been transported by a ship.

A smaller contribution to the flora was given by ØRSTED in 1841 in an account of an excursion to an alluvial deposit at Hofmansgave³, where some blue-

¹ J. W. HORNE-MANN, Dansk oekonomisk Plantelære 3. Udg. 2. Del. 1837.

² F. LIEBMAN, Bemærkninger og Tillæg til den danske Algeflora. KRØYER's Naturhist. Tidsskrift 2. Bd. 5. Hefte, 1839.

³ A. S. ØRSTED, Beretning om en Excursion til „Trindelen“, en Alluvialdannelse i Odensefjord. KRØYER's Naturhistorisk Tidsskrift 3. Bd. 1841, p. 552.

green Algæ were especially mentioned, amongst others a new species *Spirulina subsalsa*.

ØRSTED's dissertation¹, published three years later, in which the distribution of the marine Algæ in the Sound is discussed, is of greater importance. In this paper, which deals with the geographical, geological, botanical and zoological conditions of the Sound, all the species of Algæ are mentioned, which were found there by the author, but the single species are not described in detail, which is the reason why it is not always possible to know the meaning of a name given by the author. A number of species, considered by him as new, are however described in the comments under the text, but mostly so briefly and incompletely, that the plant cannot be recognised; and the result has been, that none of the genera and species, given by ØRSTED, have been maintained. Some of them have later been published in *Flora Danica*. The systematic value of the paper is thus very small, but its importance for our subject lies in this that it is based upon systematic investigations by means of dredgings, with the result, that for the first time the Algæ are not only discussed in regard to their horizontal distribution but also in regard to their vertical. It cannot be determined what new species have been added to the flora by ØRSTED's work without examining his specimens.

Already several years before the appearance of ØRSTED's work, LYNGBYE in 1836 had written a treatise of a somewhat kindred character, but, on account of special conditions, it was not published before 1880². In floristic regard it is not of so much importance in enriching the flora, as in its being based upon investigations in the southernmost part of the Kattegat off Gilleleje, a region not investigated before, and especially by its containing more exact data on the distribution of the Algæ in relation to the depth. Neither his nor ØRSTED's divisions into regions of depth need be mentioned here.

Since ØRSTED's work there has not until the end of the 19th century appeared any noteworthy, floristic or systematic contribution to the Danish literature on the Danish marine Algæ. In *Flora Danica* marine Algæ from Denmark were included up to 1861, but very few new species were added beyond those mentioned by LIEBMAN and ØRSTED. *Helminthocladia purpurea*³, found by Miss CAROLINE ROSENBERG, is perhaps the most interesting addition. During the same period publications which partly deal with the algal flora in Danish territory have appeared

¹ A. S. ØRSTED, *De regionibus marinis, elementa topographiæ, historiconaturalis freti Øresund. Hauniæ* 1844.

² H. C. LYNGBYE, *Rariora Codana* (Opusculi posthumi pars). Vidensk. Meddelelser fra den naturh. Foren. i Kjøbenhavn, 1879—80, p. 215.

³ In "Nomenclator Floræ Danicæ" published by JOH. LANGE in 1881 a systematic summary, prepared by myself, was given of all the Algæ mentioned in this work with data on their occurrence. This general summary, which in regard to the determination of the species, is essentially based upon the references available in the literature and consequently in part out of date, comprises the following Danish marine Algæ: 47 *Rhodopyceæ*, of which two are however incorrectly named as Danish, 38 *Phæophyceæ* (1 incorrectly named Danish), 18 *Chlorophyceæ* and 7 *Cyanophyceæ*. By accident the *Characeæ* were omitted in this work.

in the neighbouring countries. Bornholm's algal flora has thus been investigated, in connection with that of the inner Baltic, by KROK¹ who gave valuable information regarding this region, not investigated until then. During the years 1870—1875 two expeditions were made from Kiel respectively to the Baltic and to the North Sea, on which occasions some dredgings were also made in the Danish waters, mostly in the Great Belt, and reports on these have been given by P. MAGNUS². By these dredgings the existence of Algæ at great depths was determined in the Great Belt, among which were some species not found before in the Danish waters (*Antithamion Plumula*, *Chylocladia clavellosa* (*Lomentaria clavellosa*), some *Lithothamnion*-species and the new species *Callithamnion* (*Rhodochorton*) *membranaceum* Magn.).

The marine Algæ have not in general been included in the Danish local floræ, or only the most obvious mentioned *en passant*; in J. P. JACOBSEN's list of the plants³ found in Læsø and Anholt only some few species of marine Algæ from each of these islands have also been mentioned. COLLIN's work on the marine fauna⁴ of the Limfjord contains some remarks about the flora of this fjord, in which some of the most important species in the composition of the flora are mentioned, partly from the information given by J. P. JACOBSEN. The number of the species stated is however also here too small to be of any importance in floristic regard. One of the species mentioned, *Rhodomenia mamillosa* (*Gigartina mamillosa* (Good. et Woodw.) J. Ag.) is however of interest, as it had not previously been found on the coasts of Denmark.

For two smaller groups however we find special contributions in the literature. The *Characeæ*, which in this country have not usually been studied in connection with the other Algæ, were included in two editions of LANGE's manual⁵ and were later exhaustively studied by P. NIELSEN, especially in South West Sealand⁶. In 1880 I published a preliminary report on the submarine *Vaucheria*-species, the number of the known Danish species being thereby augmented⁷.

Collections employed for the present work.

My work is naturally mostly based upon my own collections, but it need hardly be said that I have also employed all the marine Algæ accessible to me

¹ Th. O. B. N. KROK, Algfloran i inre Östersjön och Bottniska viken. Öfversigt af K. Vet. Akad. Förhandl. 1869.

² P. MAGNUS, Botanische Untersuchungen der Pommerania-Expedition vom 3. bis 24. August. Aus dem Bericht über die Expedition . . . Pommerania. Kiel 1873.

P. MAGNUS, Die botanischen Ergebnisse der Nordseefahrt vom 21. Juli bis 9. Septbr. 1872. II. Jahresber. der Kommission z. Unters. d. deutsch. Meere in Kiel. Berlin 1874.

³ J. P. JACOBSEN, Fortegnelse over de paa Læsø og Anholt i 1870 fundne Planter. Botan. Tidsskrift. 11. Bind 1879.

⁴ JONAS COLLIN, Om Limfjordens marine Fauna. Kjøbenhavn 1884.

⁵ JOH. LANGE, Haandbog i den danske Flora. 2. edition 1859, 3. edition 1864.

⁶ P. NIELSEN, Exsiccatsamling af Characeer, navnlig fra Danmark. 1869. Idem, Sydvestsjællands Vegetation. Botanisk Tidsskrift 2. R. 2. Bd. 1873.

⁷ Botanisk Tidsskrift Bd. 12, p. 11.

which have been collected in Danish waters by others in earlier and more recent times.

Other collections. LYNGBYE's herbarium of Algæ, kept in the Botanical Museum of Copenhagen, is of the greatest importance for the study of the Danish marine Algæ, as it contains the original specimens of LYNGBYE's Hydrophytology. The specimens in this herbarium have not been particularly well prepared, but they are furnished with exact indications of the place and time of collecting; most of them originate from the neighbourhood of Hofmansgave on Fyen.

The Botanical Museum's Danish herbarium contains a considerable number of specimens of marine Algæ. The majority of these come however, like LYNGBYE's herbarium, from the neighbourhood of Hofmansgave and have been collected mainly by HOFMAN BANG and Miss CAROLINE ROSENBERG. The latter, who passed the greater part of her life († 1902) at Hofmansgave, has from there during a long series of years sent a large number of carefully prepared specimens of marine Algæ, many of which have come to be housed in the Botanical Museum's herbarium. As they have been collected at different seasons, they provide a good material for following the development of the single species during the course of the year. Further, specimens are also present from HORNE MANN, LIEBMAN and ØRSTED, by which the determinations of the latter can be controlled, and also from J. VAHL, C. M. POULSEN, JOH. LANGE, CHR. THOMSEN (mostly from Samsø), J. P. JACOBSEN (mostly from the Limfjord), E. ROSTRUP, C. RASCH and others.

Since I began my systematic collections, some material collected by others has further been left to me. Dr. TH. MORTENSEN has thus placed at my disposal a valuable collection principally from the Limfjord procured at different seasons in 1894—95; and Dr. F. BORGESSEN has permitted me to examine the Algæ dredged on two expeditions with the fishery-inspection ship S. S. "Guldborgsund" in 1897 and in 1898 in the Skagerak, Kattegat and the Baltic. Smaller collections have been given me by Dr. C. H. OSTENFELD, Mr. A. OTTERSTRØM, Mag. OVE PAULSEN and Mag. HENNING E. PETERSEN.

My own collections. I began my first collections of Danish marine Algæ already [towards the end of the seventies, but it was not until 1890 that I made extensive and systematic collections and they were carried on most energetically during the years 1891—1895, whilst later they have been continued almost every year though less extensively. My aim has been to make as uniform an investigation of the Danish waters as possible and also, as far as possible, to investigate them at different seasons; for that purpose I have made dredgings at more than 700 different places and besides made collections at numerous harbours and at other places close to the land; I have made these collections during all the months of the year, chiefly however during May—September. The dredgings have almost all been made by means of a triangular dredge with sharp steel teeth (Reinke's model), more rarely with a quadrangular dredge without teeth or with seine. The greater part of the material has been preserved as herbarium specimens, of which I possess

ca. 8000 samples, averaging at the least twice as many specimens. I have also preserved several hundreds of specimens in alcohol or formalin and likewise a considerable number of samples of stones and the like with incrustated Algæ. Neither the conditions nor time have as a rule permitted a more exact examination of the collected material at the place investigated; the aim was to keep or at least to note all the species present at the single dredging localities. I have however, during longer stays at some places on the Danish coasts, been able to make closer microscopical examination of fresh material. The main portion of my investigations is however based upon preserved material.

Remarks on the Danish waters.

As the present work does not intend to give a complete account of the floristic conditions nor of all the algal communities, the natural conditions of the Danish waters need not be described in detail here, but only the most important points, which may serve as a guide for understanding the distribution of the separate species and their biological conditions.

The boundaries of the region. These are partly determined by the political limits. Thus, my investigations extend southward in the North Sea to the boundary towards Slesvig, and east of Jutland as far as a line drawn between the German and Danish territories thus to the boundary of the region investigated by REINKE¹. I have made dredgings in the North Sea as far out as the lightship on Horns Reef and the eastern side of the Jutland Reef ca. 24 miles from land, in the Skagerak ordinarily only to 4 miles from the land except north of Vendsyssel where the distance is greater. In the Kattegat my investigations have extended to the eastern channel and the grounds in and near it, and in the Sound to the deep channel east of Hveen in order to obtain the flora belonging to the salt under-current there. The waters surrounding Bornholm constitute a special region, which is however connected with the waters east of Møen by some few scattered dredgings.

The conditions of depth. A general view of these is obtained from the charts, which show that a deep channel (the eastern channel) passes from the Skagerak southward through the eastern Kattegat, while the water in the western part of this sea is relatively shallow. Narrower channels lead further from the eastern channel through the Sound and the Belts, of which that through the Great Belt is the most important. At Gjedser—Darsserort this channel meets with a barrier, the maximum depth over which is 18 meters, whilst a similar barrier, which has a maximum depth of only 8 M., occurs at Saltholm and forms the southern boundary of the deep channel through the Sound. South of Schonen the depth increases in the Baltic, but becomes specially considerable north and east of Bornholm. For the rest, reference may be made to the charts.

¹ J. REINKE, *Algenflora der westlichen Ostsee deutschen Antheils*. 1889.

The nature of the bottom. The most important kinds occurring in the Danish waters, are (1) stony bottom, (2) sand-bottom and gravel-bottom, (3) mixed bottom consisting of a mixture of sand and clay or mud and (4) soft bottom consisting of clay or mud. To these may be added (5) rocky bottom and (6) compact clay (tertiary or glacial). I shall not endeavour here to describe more closely the distribution of these kinds of bottom, as the nature of the bottom is very variable from place to place. With regard to the Kattegat reference may be made to C. G. JOH. PETERSEN'S chart¹. For the rest some information is given below in the list of my dredgings; it may however be remarked, that I have chiefly dredged at places with stony bottom. The rule is, that sand-bottom is connected with shallower water, soft bottom with the deeper and mixed bottom with the intermediate depths. The stones are mostly found in shallow water and on reefs, which are for a great part noted on the charts. There are grounds, however, the surface of which is exclusively or predominantly sand, e. g. Horns Reef, Anholt's N. W. Reef and Gjedser Reef, which is the reason, why they are not overgrown with Algæ. The extent of the true stone-reefs, the surface of which consists only of stones, is relatively small; on the larger banks and flats stony bottom is ordinarily inter-mixed with gravel, sand or even clay. In deep channels with strong current stony bottom is often found, which is kept clean by the current. Rocky bottom is found at several places near Bornholm, but elsewhere is scarcely known with certainty; it occurs perhaps at some places in the Skagerak near Hanstholm and Bulbjerg. On the other hand, firm glacial clay occurs at many places in the Skagerak and firm tertiary clay at all events in the Little Belt.

The salinity and temperature of the sea-water. As these conditions are of the greatest importance in understanding the distribution of the species, the conditions which are of special importance for our subject may briefly be discussed here; for the rest, reference may be made to the hydrographical works mentioned below². In consequence of the fact that the salinity in the North Sea is more than 32⁰/₀₀, while in the true Baltic (east of Gjedser—Darsserort) it is ordinarily less than 10⁰/₀₀, the greater part of the Danish waters is a mixed region with complicated and variable hydrographical conditions, the most important moment in which is that the heavy North Sea water from the Skagerak penetrates along the bottom through the deep channel in the eastern Kattegat and further as

¹ C. G. JOH. PETERSEN, Kanonbaaden Hauchs Togter, 1893, Kort III.

² MARTIN KNUDSEN, Havets Naturlære. Hydrografi med særligt Hensyn til de danske Farvande. Skrifter udg. af Kommissionen for Havundersøgelser. Nr. 2. København 1905.

De internationale Havundersøgelser 1902—1907. Skrifter udg. af Kom. f. Havundersøg. Nr. 4. 1908.

J. P. JACOBSEN, Mittelwerte von Temperatur und Salzgehalt, bearbeitet nach hydrographischen Beobachtungen in Dän. Gewässern 1880—1907. Meddel. fra Komm. for Havundersøgelser Ser. Hydrografi. Bind I, Nr. 10. 1908.

Nautical-meteorological Annual 1902—1906, published by the Danish Meteorological Institute.

I am much obliged to Mr. J. P. JACOBSEN for placing at my disposal some unpublished lists with hydrographical averages. I am much indebted to Mr. MARTIN KNUDSEN and Mr. J. P. JACOBSEN for various pieces of information regarding the hydrography of the Danish waters.

a bottom-current through the channels in the Sound and the Belts, especially the Great Belt, while a surface-current streams out from the Baltic in an opposite direction. On account of the rotation of the earth this northward so-called Baltic Current is forced eastward and consequently remains on the eastern side of the Kattegat along the Swedish coast, and for the same reason the north-going surface-water moves more rapidly in the Sound than through the Belts. Vice versâ the salt bottom-current is forced westward. The boundary between the two water-layers is very distinct in summer, while the transition is uniform in winter.

The salinity does not vary much in the North Sea. At the lightship on Horns Reef the conditions in the years 1880—94¹ were:

Temperature			Salinity	
	Mean minimum	Mean max.	Mean minimum	Mean max.
0 M.	2,2° (Febr.)	15,8° (Aug.)	32,7 ‰	33,2 ‰
23 -	2,6° (March)	15,5° (Sept.)	33,1 ‰	33,7 ‰

The numbers are the averages of the monthly means; the variations are thus a little greater than indicated by the numbers. Along the coast a narrow and not very deep margin occurs with a somewhat lower salinity.

The conditions in the part of the Skagerak which lies nearest Jutland are essentially like the corresponding part of the North Sea, the water mainly streaming from the North Sea towards the Swedish coast.

In the waters inside the Skaw (Skagen), at every place where the depth is considerable, an upper, relatively not very salt layer, the temperature of which almost constantly follows that of the air, can be distinguished from a deeper layer with saltier water and with special conditions as to temperature. With regard to the surface water, the highest temperature of the year is commonly observed in the beginning of August and is in the greater part of the waters on an average 16°, while the lowest temperature of the year, which on an average is 2°, is ordinarily observed in the middle of February. In fjords and bays, where the renewal of the water is not considerable, the maximal temperature is however higher and falls in July, and the minimal temperature is lower in winter. In the deeper and saltier water-layers both the maximal temperature and the minimal temperature occur later than at the surface, and the maximum temperature is lower than at the surface, the minimum temperature higher. The differences from the surface are various but are essentially regulated by the depth.

With regard to the hydrography of the Limfjord only some few observations are available. In this shallow water there is only a small difference between the surface and the deeper water-layers. The water in the western part is most like that of the North Sea, the eastern part like the surface-water of the Kattegat. It is only for Oddesund and Aalborg that continuous observations on the surface-water are available. In 1902—1906 the salinity at Oddesund was on an average

¹ Meteorologisk Aarbog for 1896.

29,3^{0/00} (the monthly mean was 26,3—32,4^{0/00}); at Aalborg it was during the same period on an average 23,5^{0/00} (18,4—27,7^{0/00}). At the same time the monthly mean temperature at Oddesund alternated between $\div 0,2^{\circ}$ (Febr.) and $18,5^{\circ}$ (July). At Aalborg it alternated between $\div 1,4^{\circ}$ and $18,3^{\circ}$. The conditions characteristic of the Limfjord are: a relatively high salinity, especially in the western part, a higher summer temperature than in the open waters and the absence of a salter under-layer with smaller alternations in the temperature.

In the northern Kattegat, north of Læsø, an active exchange takes place between the surface-current and the under-current, which is the reason why the salinity decreases considerably in both from north to south. As a rule the salinity of the water streaming in at Skagen is between 30 and 35^{0/00}, and the salinity of the surface-water is ordinarily more than 25^{0/00}. According to J. P. JACOBSEN the result of daily observations for 1880—1905 shows, that the temperature and salinity at Skagens Reef vary on an average in the following manner;

	Temperature	Salinity
0 M.	2,5°—16,2° (mean 8,8°)	27,3—31,4
20 -	3° —15°	32,3—33,8
38 -	4° --13,9° (mean 8,2°)	33,3—34,5

At Læsø Trindel the salinity, according to the charts in J. P. JACOBSEN's paper, is: at 0 M. 23—27^{0/00}, at 10 M. 28—29^{0/00}, at 20 M. 31—32^{0/00}.

In the eastern Kattegat the salinity of the surface water gradually decreases southward; not nearly so great an exchange however occurs here as in the northern Kattegat.

At Anholt's Knob the salinity is at 0 M. 19—23^{0/00}, at 10 M. 23—25^{0/00}, at 20 M. 29—31^{0/00} and at the same place the temperature alternates at the surface between $1,6^{\circ}$ (mid. Febr.) and 17° (ca. 1. Aug.) at a depth of 28 M. between $4,2^{\circ}$ and $13,5^{\circ}$, at a depth of 40 M. between 4° and $11,5^{\circ}$.

In the western Kattegat (Km.), which is only of small depth, the salt bottom water is absent, except in Læsø Channel. At the lightship in Læsø Channel in 1880—94 the averages were:

	Temperature		Salinity	
	mean minim.	mean max.	mean minim.	mean max.
0 M.	2,2° (Febr.)	16,1° (July)	22,3 ^{0/00}	27,8 ^{0/00}
24 -	3,4° (March)	13,9° (Aug., Sept.)	32,2 ^{0/00}	33,9 ^{0/00}

The salt water coming through the Læsø Channel causes on mixing the water in this region to become relatively saline, especially to the north and along the coast of Jutland. In the greater part of the region the salinity at the bottom is however not more than 25^{0/00}.

In the Southern Kattegat and the waters east of Samsø the salinity at the surface is fairly uniform. In this area there is, especially in summer at a depth of 10—20 M., a very distinct limit between an upper layer, which has ca. 20^{0/00}

salinity, and an under layer, which has 28—32^{0/00}. Where the depth is greater the salinity is even higher. At Schultz's Grund it increases during the summer months, when it is greatest, up to 32—33^{0/00} at a depth of 26 M. During the winter months the salinity at the bottom is less (at Schultz's Grund ca. 29—30^{0/00}), while at the same time the surface salinity increases on account of the intermixing. The maximal temperature at the bottom is relatively low, lower than it is both north and south of the region. The mean temperature of the bottom-waters for the year is 7°. According to J. P. JACOBSEN (l. c.) the conditions at Schultz's Grund are the following:

0 M.	10 M.	20 M.	26 M.
Salinity	Salinity	Salinity	Salinity
16—21,6 ^{0/00}	19,9—23,3 ^{0/00}	27,8—31,5 ^{0/00}	29,1—32,9 ^{0/00}
Temperature	Temperature	Temperature	Temperature
1,5° (Febr.)—17° (Aug.)	2° (Febr.)—16,5° (Aug.)	3,3° (Mch.)—13° (Aug.)	3,8° (Mch.)—12° (Aug.)

In the area between Samsø, Jutland and Fyen the depths are mostly not more than 20 M. The salinity at the surface increases considerably towards the Jutland coast, where it is greater than in the adjacent regions, which is caused by the salt bottom-water here being nearer the surface and mixed with the surface-water. On account of this also the surface water's maximum temperature is here 1° lower than in the Kattegat. At a depth of 20 M. the salinity is 25—30^{0/00}, the temperature 2,5—13,5.

To illustrate the conditions in the Isefjord the following averages for the surface-water at Rørvig, near the mouth, and at Frederikssund, half way up Roskildefjord, during the years 1902—1906 may be given:

	Salinity	mean temperature in	
		February (the coldest month)	July (the warmest month)
Rørvig.....	19,4 ^{0/00}	0,6° (÷ 0,9—+1,8)	17,3° (16,1—18,7)
Frederikssund...	15 ^{0/00}	0,4° (÷ 0,6—+1,9)	18,0° (16,6—19,7)

In the Great Belt the salinity of the surface-water is very variable. Thus, at Sprogø it varies between 10^{0/00} and 20^{0/00}. The highest salinity is found at the coast of Fyen. A salt bottom-water is found here, but the boundary between this and the surface-water is here not so distinct as in the Kattegat. At a depth of 20—25 M. the temperature alternates between 3° and 13°, at the same depth the maximum salinity is reached in July and is 27^{0/00}.

The following averages for 1895—1902 illustrate the conditions (manuscript lists). The western part of the Great Belt; 55°18' N. L. 10°54' E. L.

	Temperature		Salinity	
	Min.	Max.	Min.	Max.
0 M.	2,2 (March)	16,6 (Aug.)	13,4 ^{0/00}	18,3
15 -	2,2 (March)	13,9 (Sept.)	17,1 -	24,3
23 -	2,4 (March)	13,2 (Sept.)	18,7 -	27,6

In the Little Belt there is only a small difference between the salinity at the surface and in deep water; it is about 20⁰/₀₀ or a little less. The temperature at the surface is comparatively low in summer (during 1902—1906 on an average 13,7° in June, in July 15,2°, in Aug. 15,1°), comparatively high in winter (during the same period 2,5° in January, 1,7° in Febr.). There is generally a strong current, especially in the narrowest part of the Belt.

In the Sound a salt bottom layer is found as far as Saltholm Tærskel, sometimes however passing it. The salinity greatly decreases southward in the upper layers. The salinity of the bottom-layer also decreases southward; north of Hveen it is 25—28⁰/₀₀ at a depth of 20 M. In deep hollows the salinity may be 30—32⁰/₀₀ and here the temperature in winter is constant for a long time. The following numbers found at the lightship on Lappegrunden are very instructive.

Average of 1883—94 (Meteorol. Aarbog):

	Temperature		Salinity	
	Min.	Max.	Min.	Max.
0 M.	1,0° (Febr.)	17,0° (July)	12,0 ⁰ / ₀₀	16,7 ⁰ / ₀₀
11 -	3,1° (March)	15,7° (Aug.)	21,0 -	26,2 -
17 -	4,1° (March)	11,5° (Sept.)	28,3 -	32,8 -
23 -	3,5° (April)	11,3° (Oct.)	28,3 -	34,0 -

North of Saltholm (1880—1907):

Salinity 0 M. 10—13⁰/₀₀, 10 M. 13—16⁰/₀₀.

In the western Baltic there is also, at any rate in the summer, a contrast between the surface-water and the salt bottom-water, but as a considerable mixing occurs the surface-water west of Fehmarn is comparatively salt, 11—18⁰/₀₀, and has a somewhat lower temperature in summer than in the true Baltic. The salt bottom-water has its maximal salinity in July and August, when it is ca. 20⁰/₀₀ at a depth of 20 M. In the area between Fehmarn and Gjedser—Dars—Tærskelen the salinity decreases considerably in the upper water-layers eastwards. The salinity also decreases somewhat in the bottom-water (ca. 15—20⁰/₀₀ at a depth of 20 M.).

At the lightship on Gjedser Reef the average salinity was in 1880—94:

0 M.	8,7—12,8 ⁰ / ₀₀
8 -	9,8—13,6 -
11 -	11,1—14,1 -

In the Baltic round Møen, from Gjedser to Sweden, the salinity and temperature are fairly uniform from surface to bottom. At Møen the salinity at the surface is on an average ca. 8⁰/₀₀, at a depth of 20 M. 8—10⁰/₀₀. From this place the salinity increases both at the surface and at the bottom towards the two entrances, the Gjedser—Dars—Tærskel and the Drogden Tærskel.

To illustrate the hydrography of the Baltic round Bornholm it may be mentioned that the salinity of the surface-water at Christiansø in 1902—1906 was on

an average $6,7^{0/100}$ (the monthly means varying between $5,5$ and $8,8^{0/100}$). A salter bottom-water is found here, but only at a rather considerable depth. At a station north of Bornholm, $55^{\circ}26'$ N. L. $14^{\circ}46'$ E. L., the salinity of the surface-water is ca. $7-8^{0/100}$, of the bottom-water ca. $13-15^{0/100}$. The boundary lies at a depth of about 60 M. The salinity however increases somewhat above this boundary, as will be seen from the following numbers found by the international investigations during the years 1903—1907 (Bulletin trimestriel).

North of Bornholm $55^{\circ}26'$ N. L., $14^{\circ}46'$ E. L. The salinity were at depths of:

0—30 M. . . .	$8^{0/100}$
40 - . . .	$7,32-11,56^{0/100}$
50 - . . .	$7,38-11,94$ -
60 - . . .	$10,61-14,89$ -

The currents in the Danish waters are complicated and variable; they depend not only on the above-mentioned exchange between the waters of the North Sea and the Baltic, but also on the wind, in a less degree on the tide and of course on the configuration of the coast and the bottom. When the wind is strong it determines the strength and direction of the surface currents. Thus, with westerly winds salt surface-water streams from the Skagerak into the Kattegat, and from the Kattegat a northerly current brings relatively salt water in through the Sound and the Great Belt. Easterly winds produce the contrary effect. A sudden change in the direction of the wind often causes a strong current, especially in the narrow belts and sounds. There is on the whole almost always a more or less strong current in the latter, e. g. in the Little Belt, in the Sound at Helsingør, sometimes as strong as in a river. That currents can be produced by the tide is not only seen at the most southerly part of the Jutland west coast, south of Skallingen, but also at some single places inside Skagen, for instance in the bay inside Korsør and in some of the Sounds in the Smaaland Sea, where the current, at any rate during calm conditions of the weather, regularly changes with the tide (every 6 hours).

The height of the water-level at the Danish coast is only in a small degree dependent on the tide. This is only at the southern part of the Danish North Sea coast of a fairly considerable magnitude. North of Thyborøn channel and in the waters inside Skagen its greatest height is only at some few places 1 foot or a little more, at other places it is only some few inches, and at Bornholm there is no tide at all. According to "the Danish Pilot"¹ the following heights occur:

The North Sea and Skagerak	Waters inside Skagen
mean high-water above mean low-water	the mean height of the spring-tide
Eshjerg 5 feet	Frederikshavn . . 1 foot
Nordby (Fanø) 4 — 9 inches	Aarhus 1 — 2 inches
Blaavands Huk 5 —	Fredericia " — 11 —
Nyminde Gab 3 —	Korsør " — 11 —

¹ Den danske Lods; 4. edit. 1893, p. 29.

The North Sea and Skagerak				Waters inside Skagen			
mean high-water above mean low-water				the mean height of the spring-tide			
Thyborøn channel ..	1 foot	6 inches		Slipshavn	1 foot		
Agger	1	—	1 —	Helsingør	"	—	5 inches
Hirshals	1	—	" —	Copenhagen	"	—	7 —
Skagen	1	—	" —				

The figures for the places inside Skagen are so small that they are often neutralized by the change of level caused by the winds. The wind's influence on the height of the water-level is at many places very distinct and well known. Thus, westerly winds cause a high level of the water in the Kattegat on account of the influx of water from the Skagerak, while easterly winds cause a low level of the water. With the variable winds, so pronounced in our country, the changes in the level of the sea are also very variable; but as certain directions of the wind are predominant at certain seasons, others at other seasons, the average height of the water-level is also different at different periods of the year. From ADAM PAULSEN a general summary is given here of the average deviations of the water-level at three different places on the Danish coasts from the height of the mean water-level during the twelve months of the year, calculated as the averages of observations made during the years 1889—1902¹.

The annual variation of the height of the water-level.

Station	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
Hirshals	—0,3	—4,6	—8,8	—10,8	—10,7	—2,2	5,2	7,2	8,8	6,6	3,7	6,6(4)
Frederikshavn	1,2	—4,7	—7,4	—11,6	—9,6	—3,2	3,9	5,5	6,6	6,7	5,3	7,3(5)
Fredericia	0,6	—2,7	—4,5	—6,6	—5,4	—2,6	1,3	2,8	5,1	6,0	3,4	2,6(2)

The numbers in parenthesis for December indicate the annual mean-height of the water during this month, when the extraordinary mean-height for December 1898 is left out of consideration.

It appears from this, that the lowest water-level at all three places is in April, and it is in agreement with this, that easterly winds according to simultaneous observations are most predominant in April. This condition is of the greatest importance to the upper littoral vegetation, and it is the reason why an upper belt of vegetation, which has grown perfectly well during the course of the winter, is killed every spring.

Division of the Danish waters. To facilitate the summary over the distribution of the Algæ, I have not only maintained the ordinary divisions, but have also made further subdivisions in the Kattegat and Baltic. These will be found

¹ ADAM PAULSEN, Meddelelser om det danske meteorologiske Instituts Vandstandsmaalinger. (Account of the measurements of the height of the sea-level, carried out by the Danish Meteorolog. Institute. Nautisk-Meteorologisk Aarbog 1906, København 1907.

on the present chart, and the boundaries are more exactly indicated below. The limits between the waters are for the most part those commonly accepted (see e. g. "The Danish Pilot"); I have however moved the boundary between the Kattegat and the Sound a little to the south-east for the purpose of including the Ostindiefarer Grund and Søborghoved Grund, and I have moved the southern boundary of the Sound up to the southern point of Amager, as a distinct biological boundary is found nearly at this place.

North Sea. **Ns.** Boundary towards the Skagerak: Hanstholm point.

Skagerak. **Sk.** The boundary towards the Kattegat is a line from Skagen to the Paternoster rocks at Marstrand.



The northern part of the Kattegat. **Kn.** The boundary to the south is a line from Sæby to Læsø north-west Reef, the north coast of Læsø, and a line from the east point of Læsø due east.

The eastern part of the Kattegat. **Ke.** The boundary to the west is marked by the Kobber Grund and a line from its south point to the east point of Anholt and thence to Gilbjerg Hoved on Sealand; the boundary towards the Sound is a line from Nakkehoved to the point of Kullen.

The central part of the Kattegat. **Km.** The boundary to the south is a line from the south point of Anholt to Fornæs Point.

The southern part of the Kattegat. **Ks.** The boundary to the south-west is a line from the end of the Sjællands Odde to Hjelm.

The Samsø area. **Sa.** The boundary towards the Little Belt is a line from Æbelø to Bjørnsknude and towards the Great Belt a line from Fyens Hoved to Refsnæs Point.

The Little Belt (Lillebælt). **Lb.** The boundary to the south is a line from Pøls Huk on Als to Vejsnæs on Ærø, and towards the South Fyen waters a line from Hornenæs to Skjoldnæs.

The South Fyen waters (Sydfynske Øgaard). **Sf.** The boundary towards the Great Belt is a line between Turø Reef and Næs Hoved on Langeland.

The Great Belt (Storebælt). **Sb.** The boundary to the south is a line between Gulstav at Langeland and Kappel church on Lolland, towards the Smaaland Sea a line from Korsør passing Egholm, Agersø, Omø and the south-westerly Omø Staal Grund to the eastern point at Onse Vig in Lolland.

The Smaaland Sea. **Sm.** The boundary towards the Baltic off Grønsund is a line round Tolken, towards the Baltic off the Bøgestrøm a line round the sand shallows to the Bøgestrøm buoy.

The Sound (Øresund) **Su.** The boundary towards the Baltic off Grønsund is a line from the south point of Amager eastward.

The western Baltic. **Bw.** To a line between Gjedser and Darsserort.

The Baltic round Møen. **Bm.** To a line from the north end of Rügen northward.

The Baltic round Bornholm. **Bb.** The waters surrounding Bornholm.

Remarks on the dredging localities.

I have considered it useful to make a list of all the localities where I have dredged and to give information about the depth, the nature of the bottom and the vegetation at each. They are also indicated on the accompanying charts by signs, illustrating the vegetation. By means of this it will be possible in the following to give a detailed account of the occurrence of the single species in the Danish waters without too great prolixity, and, by means of the list and the charts, to contribute perhaps to the characterization of the separate waters with regard to the vegetation, even if the dredging localities are not so near each other, that they can serve as base for a chart showing the distribution of the vegetation. To obtain this, much more numerous observations than I have been able to make are necessary. The Danish waters are so complicated, and the nature of the bottom often so variable from place to place, that it is not possible, from the dredging at one place to draw conclusions as to the conditions at another close by. It may also be remembered, that the aim of my investigations was not so much to determine, to what extent the bottom was overgrown, as to study the distribution and the mode of occurrence of the single species. That is why I have usually preferred to dredge at places where I could expect the bottom to be overgrown. If the result has nevertheless been, that so great a number of the dredging localities have proved to be without vegetation, the reason is, that a relatively large

part of the bottom in the Danish waters is not overgrown, especially in the more open waters. This is especially the case with regard to the North Sea, which is quite without vegetation except at some few places in the most northern part of the region referred to here. In the Skagerak the greater part of the bottom is also quite without vegetation, even on stony bottom Algæ are often lacking. Here and there some small overgrown plots are however found, but it is only at some few places that a more abundant vegetation is found, especially near the land, e. g. at Hirshals and Bragerne. Also in the other waters large tracts are without vegetation, especially the soft bottom, which in the Kattegat and the Baltic extends over wide areas in the greater depths.

A main rule is, that the total quantity of the vegetation is generally the greater the more sheltered the place is. It must however be remembered, that in the more sheltered waters we have the *Zostera*, which grows on sand bottom or on mud bottom more or less mixed with sand¹, while the algal vegetation is found on stony bottom. The last applies not only to bottom exclusively or predominantly consisting of stones but also to sand bottom or soft bottom with scattered stones. On the last mentioned kind of bottom there is commonly, according to the conditions, scattered algal vegetation or *Zostera* vegetation with Algæ, which is indicated on the charts by a special sign. But also on true stony bottom scattered algal vegetation is often found especially in deeper water. In such cases the locality is however indicated on the charts with the same sign as those with uninterrupted algal vegetation. Only when the vegetation is practically lacking, but where however some few scattered specimens of Algæ were found, is the locality indicated with ☉.

It is important to distinguish between Algæ grown on the dredging locality and those found loose². In some cases where such Algæ occur they have been brought by chance from another locality, in other cases they appear in large quantities and always at the same place, where they keep living for a long time. Such collections of loose Algæ are found e. g. at some places near Anholt and near Møen; they are given a special sign. Of a different nature is a number of more or less transformed loose forms of different algal species connected with the *Zostera* vegetation; probably they have been carried into this vegetation after having been torn loose, but when there have been kept among the *Zostera* plants and have gone on living perhaps for a long time, propagating by division, while reproduction by spores has ceased and the appearance has become more or less transformed³.

¹ C. H. OSTENFELD, Aalegræssets (*Zostera marina*'s) Væxtforhold og Udbredelse i vore Farvande. Beretn. fra den danske biologiske Station. XVI. 1908. (Report from the Danish Biological Station. XVI.)

² Such a distinction has not been made in C. G. JOHNS. PETERSEN, "Kanonbaaden Hauchs Togter" where the signs indicating the *Zostera*, *Laminaria* and some other higher Algæ in the Kattegat are given on the Atlas, Plate III (1893). In some single cases at any rate, plants are here noted as growing at localities, where according to my experience the bottom is quite without vegetation.

³ The largest and perhaps the best known is *Ascophyllum nodosum* f. *scorpioides*; of others may also be mentioned: *Phyllophora Brodiaei*, *membranifolia* and *rubens*, *Ahnfeltia plicata*, *Polysiphonia nigrescens* and *violacea*, *Cladostephus verticillatus*, *Halopleris filicina* and *scoparia*, *Sphacelaria cirrosa* etc.

In the following list of the dredging localities are indicated for each locality the most common and predominant species, which above all others contributed to the characterization of the vegetation, the most important first, the less predominant in parenthesis. With regard to the indication of the locality it must be remarked that the bearings are always by compass. Besides the localities mentioned in the list, I have also made collections at many harbour-piers, stone-reefs and at other places near the land, which are for the most part indicated by a mark on the charts together with the name of the place concerned. In the list the localities are arranged for the North Sea from south to north, for the Skagerak and the Limfjord from west to east, for the rest of the waters generally from north to south, or from without inwards, in the Baltic however essentially from west to east. In the Samsø region the area east of Samsø is distinguished from that west of this island. The same method as in the lists will be kept in the following pages. To facilitate the orientation the detailed list is supplemented by a chronologically arranged summary of the dredging localities with indications of the waters where they are situated.

List of stations arranged according to the different waters.

North Sea. (Ns)

- aH. $\frac{5}{8}$ 1905. Vyl light-ship N.W. by W. $\frac{1}{2}$ W., 6 miles. — 20 meters. — Fine grey sand with shells. — No vegetation (at the same station Dr. A. C. JOHANSEN took, in 1903, several fresh *Laminaria* together with *Halidrys* and *Furcellaria* in trawl, but it was uncertain whether they were growing on that spot).
- aL. $\frac{5}{8}$ 05. Vyl light-ship S.E. $\frac{1}{2}$ S., $6\frac{1}{3}$ miles. — 25 meters. — Coarse sand with small pebbles. — No vegetation.
- aI. $\frac{5}{8}$ 05. Vyl light-ship S.W. $\frac{1}{4}$ W., $6\frac{1}{3}$ miles. — 9,5 meters. — Firm coarse sand (with small pebbles). — No vegetation.
- aK. $\frac{5}{8}$ 05. A little more south than aI. — 8 meters. — Coarse sand with pebbles. — No vegetation.
- aQ. $\frac{8}{8}$ 05. A tract immediately N. of the light-buoy at the south end of Slugen (Horns Reef). — 7,5 to 19 meters. — We searched here with grapnel for a wreck and dredged several times, but only bare sand without vegetation was found; the shells were without Algæ.
- aN. $\frac{5}{8}$ 05. Horns Reef light-ship N.W. $\frac{2}{3}$ W., a good 6 miles. — About 23 meters. — Sand with small pebbles. — No vegetation.
- aM. $\frac{5}{8}$ 05. Horns Reef light-ship N.W. by W. $\frac{1}{4}$ W., 7 miles. — 16,5 to 18 meters. — Coarse sand with a few small pebbles. — No vegetation.
- aM $1\frac{5}{8}$ 05. A little more to the south. — 22,5 meters. — Coarse sand. — No vegetation. — 24,5 meters. — Sand, pebbles. — No vegetation.
- aR. $\frac{8}{8}$ 05. Double broom at Søren Bovbjergs Knob S.E. by E. $\frac{2}{3}$ E. $1\frac{1}{4}$ miles. — 13 meters. — Sand. — No vegetation.

- aS. $\frac{8}{8}$ 05. The light buoy at the north end of Slugen W.N.W $\frac{1}{4}$ W. 3 miles. — 9,5 meters. — Sand. — No veg. (loose *Fucus vesiculosus*).
- aP. $\frac{5}{8}$ 05. Horns Reef light-ship W. $\frac{3}{4}$ N. a good $6\frac{1}{2}$ miles. — 11,5 meters. — Sand. — No vegetation.
- aO. $\frac{5}{8}$ 05. 1 mile E. of Horns Reef light-ship. — 30 meters. — Partly sand, partly stony bottom. — No vegetation.
- aB. $\frac{27}{7}$ 05. Off Harboøre; Bovbjerg light-house S. $\frac{1}{4}$ W., $6\frac{1}{2}$ miles. — 24,5 meters. — Sand, thereafter stones. — No vegetation.
- aA. $\frac{27}{7}$ 05. Thyborøn beacon E. $\frac{1}{2}$ N., ca. 10 miles. — 22 to 25,5 meters. — Coarse sand. — No vegetation.
- ZZ. $\frac{27}{7}$ 05. Thyborøn beacon S.E. by E., 5 miles, 4 miles off land. — 24,5 meters. — Sand. No vegetation.
- aC. $\frac{27}{7}$ 05. Thyborøn beacon S.E. by S. $\frac{1}{2}$ S., 3 miles. — 21 meters. — Sand, firm clay. — No vegetation.
- ZR. $\frac{24}{7}$ 05. Lodbjerg light-house E. $\frac{7}{8}$ N., $10\frac{2}{3}$ miles, near the 15 meter shallow. — 28 meters. — Sand. — No vegetation.
- aF. $\frac{1}{8}$ 05. Thyborøn beacon S.E. $\frac{1}{2}$ E., $14\frac{1}{2}$ miles. — 31 meters. — Sand with small pebbles to coarse gravel with pebbles. — Vegetation very poor to rather rich: *Ectocarpus siliculosus*, *Brongniartella*, *Chorda Filum* and *Ch. tomentosa*...
- ZQ. $\frac{24}{7}$ 05. Jutland Reef; Lodbjerg light-house E. by S., $26\frac{1}{2}$ miles. — 24,5 meters. — Gravel with small and partly a little larger pebbles. — In two dredgings *Chorda Filum*, (*Laminaria saccharina* and *hyperborea* (?), fragment ...); in one dredging *Phyllophora membranifolia* a. o.
- aG. $\frac{1}{8}$ 05. Thyborøn beacon S.E. $\frac{1}{2}$ E., $19\frac{1}{2}$ miles. — 38 meters. — *Ectocarpus siliculosus*.
- aD. $\frac{27}{7}$ 05. Lodbjerg light-house S.E. $\frac{3}{4}$ S., ca. $4\frac{1}{2}$ miles. — 23,5 meters. — Stones. — a) *Ectocarpus siliculosus*, *Desmarestia viridis*, *Flustra foliacea* with *Derbesia* a. o. — b) *Ectocarpus*, *Desmarestia aculeata*.
- aE. $\frac{27}{7}$ 05. Lodbjerg light-house S. by W. $\frac{1}{2}$ W., $7\frac{1}{3}$ miles. — 16 meters. — Sand. — Some few *Ectocarpus* and *Brongniartella*. (The dredge foul).
- XR. $\frac{9}{8}$ 00. Off Ørhage (by Klitmøller), at most 1 mile off land. — 11 to 13 meters. — Stones. — *Cystoclonium*, *Delesseria sanguinea*, *Spermothamnion*. Vegetation scare, partly wanting.

Skagerak. (Sk)

- YT. $\frac{7}{8}$ 02. N. and W. of Helshage (Hansthalm).
- 1) N. of the point. — 5,5 to 7,5 meters. — Stones. — Very few Algæ (*Delesseria sanguinea*, *Phyllophora membranifolia*).
 - 2) A little farther from land. — 9 to 11 meters. — Stones. — Very few Algæ (*Phyllophora membranifolia*).
 - 3) A shallow about off the light-house. — About 5,5 meters. — Stones. — Richer vegetation (*Dilsea edulis*, *Laminaria hyperborea*).
 - 4) Farther from land. — About 15 meters. — Stones. — Very scarce Algæ (*Deless. sanguinea*).
 - 5) Another shallow farther S. — About 13 meters. — Stones. — Richer vegetation: *Laminaria saccharina*, *Polgides*.
 - 6) From 5) landward. — 7 to 11,5 meters. — Stones. — Much the same species as in 5) but scarcer, further *Laminaria hyperborea*.

YU. ⁸/₈ 02. At Roshage (Hansthalm), near land.

- 1) Immediately E. of Roshage, on a dry rock near land, the bottom in a depth of 2 meters. — *Polysiphonia Brodiaei* (at the upper level), *Polys. nigrescens*, species of *Ceramium* . . .
- 2) Eastside of Roshage, near land. — About 2 meters. — Stones. — Abundant vegetation: *Spermothamnion Turneri*, (*Chondrus*, *Corallina* off.).
- 3) Inside the rock [1]. — 1,5 meters. — Stones. — Rich vegetation: *Chorda Filum*, *Ceramium rubrum*. . .
- 4) Off Roshage and from thence along the shore towards the landing-place. — 2 to 2,5 meters. — *Ceramium rubrum*, *Cystoclonium*, *Polysiphonia*; in some places *Laminaria digitata*; on the W. shore *Gracilaria confervoides*.

YM. ¹⁰/₇ 02. The W. and S. part of Bragerne (a bank). — 2,5 meters. — Stones. — 1) *Florideæ*, rather scarce (*Rhodomela*, *Polysiphonia violacea* var. *fibrillosa*, *Corallina* off.). — 2) The same Algæ and *Laminaria hyperborea*.

YM¹. ¹⁰/₆ 02. Bragerne. — 1 to 2 meters. — Stones. — *Mesogloia*, *Ceramium fruticulosum*, *Laminaria digitata* and *saccharina*, *Fucus serratus*, *Cystoclonium*, *Corallina* off. — 1 meter: *Laminaria*, *Punctaria*, *Spongomorpha*.

YN. ¹⁰/₆ 02. Immediately inside Bragerne. — 4,5 meters. — Stones. — *Fucus serratus*, *Laminaria digitata*.

YN¹. ¹⁰/₆ 02. A little nearer to land. — 6,5 meters. — Stones. — *Chorda Filum*, *Brongniartella*.

YN². ¹⁰/₆ 02. S. E. of Bragerne. — 10,5 meters. — Stones. — *Laminaria hyperborea*, *Chorda Filum*, *Phylloph. Brodiaei*, *rubens*, *Spermothamnion*, *Corallina* offic.

YN³. ¹⁰/₆ 02. S. E. of Bragerne, near land, towards Sandnæshage. — About 2 meters. — Sand and boulders. — Almost no Algæ (*Polysiphonia elongata*).

SZ. ²¹/₈ 94. About 2 miles N.W. of Løkken. — Stones. — No vegetation.

SY. ¹⁹/₈ 94. About 1 mile N. of Løkken. — ca. 13 meters. — Stones. — Scarce vegetation, mostly *Cystoclonium*, *Rhodomela* and *Spermothamnion*.

ZK⁰⁻¹³. ²⁻⁴/₈ 04. Off Lønstrup.

- 0) W. side of Mellemgrund, 1,5 miles from land. — 7,5 to 9,5 meters. — Stones. — *Halidrys*, *Cystoclonium*.
- 1) N. end of Stenrimmen, 2 miles from land. — ca. 7,5 to 9,5 meters. — *Laminaria digitata*, *saccharina*, *Halidrys*; *Florideæ*, mostly *Corallina* offic., *Furcellaria*.
- 2) E. end of Mellemgrund. — 7,5 to 9,5 meters. — Stones. — *Laminaria hyperborea*, *Halidrys*, *Florideæ*.
- 3) Mellemgrund. — 13 to 15 meters. — Stones. — Some few *Halidrys* and single *Florideæ*.
- 4) Grønne Grund 1 mile from land. — 9,5 to 11,5 meters. — Stones. — *Halidrys*, *Florideæ*, particularly *Cystoclonium*, *Phyllophora membranifol.*, further *Laminaria hyperborea* and *saccharina*.
- 5) Palen, abreast of Rubjergknude light-house, 1 mile from land. — ca. 11 meters. — Stones. — Veg. as in 4).
- 6) Shallow off the landing-place. — 11 to 13 meters. — Firm clay with stones. — *Phyllophora membranif.*, *Furcellaria*, *Laminaria*.
- 7) E. end of Rimmen, abreast of Rubjergknude light-house, about 4 miles from land. — 17 to 19 meters. — Stones. — *Halidrys*, *Laminaria sacchar.* and *hyperborea*. — Later, clay with pebbles and scarce Algæ, mostly *Heterosiphonia coccinea*.

- 8) A little more S. — Sand without vegetation.
- 9) Stenrimmen, about 4 miles from land. — 13 meters. — Stones. — Few Algæ; *Halidrys*, single *Florideæ*.
- 10) Mellemgrund, something more than 2 miles from land. — 11,5 meters. — Stones. — *Halidrys*, *Laminaria hyperb.*, *Cystoclonium*.
- 11) Graagrund, off Maarup church, about 1,5 miles from land. — 9,5 meters. — Stones. — Rather scarce vegetation: *Halidrys*, (*Lomentaria clavellosa*, *Cystoclonium*).
- 12) Kongshøj Grund, off Maarup church, 1 mile from land. — 8,5 meters. — Stones. — *Cystoclonium*, (*Polyides*, *Deless. sanguin.*, *Halidrys*).
- 13) Near land, immediately N. of the landing-place. — 1 meter. — Stones, clay; *Mytilus*, acorn-shells. — Various *Florideæ*, as species of *Polysiphonia*, *Gracilaria confervoides*.
- YL. ¹/₈ 01. Hirshals light-house S.E. 2,5 miles (Pullen). — 13 meters and something more. — Stones. — *Halidrys* with *Florideæ*.
- YL¹. ¹/₈ 01. Hirshals light-house S.E. 1,5 miles. — Stones. — A few specimens of *Brongniartella byss*.
- ²¹/₅ 02. Hirshals light-house S.E., ca. 1 mile (the church between the hills). — Stones. — *Flustra foliacea* with various small Algæ, *Delesseria sanguinea* (scarce *Halidrys*, *Cystoclonium*).
- ²¹/₅ 02. N. and W. end of Bredegrund, N.W. of Hirshals. — ca. 11 meters. — Stones. — Few Algæ (*Halidrys*, *Cystoclonium*, *Laminaria hyperborea*).
- ²¹/₅ 02. Within Bredegrund. — 19 meters. — Stones. — One specimen of *Halidrys*.
- ²¹/₅ 02. The channel within the stony shallows N.W. of Hirshals. — 19 meters. — Clay. — No vegetation.
- YK. ¹/₈ 01. Hirshals light-house in S.S.E. 2 miles (the church on the brook). — 14 meters. — Stones. — *Cystoclonium*, *Brongniartella*, *Laminaria digitata*. — 15 meters. — *Flustra foliacea* with few Algæ.
- XO. ⁸/₈ 99. Mølleggrund by Hirshals, ca. ¹/₂ mile from land. — 11 to 15 meters. — Stones. — *Laminaria hyperborea* and *Halidrys*, (*Laminaria saccharina*).
- ²¹/₅ 02. Off the brick-works at Hirshals, near land. — 6,5 meters. — Sand with stones. — *Rhodomela*, *Polysiphonia nigrescens*.
- ²¹/₅ 02. Off the marine hotel at Hirshals. — 4,5 meters. — Stones. — *Polyides*.
- VJ. ¹²/₈ 95. Off Hirshals, W. of the mole. — 4,5 meters. — Stones alternating with sand. — On the stones *Polyides* and *Furcellaria*.
- bD. ⁶/₇ 07. 13 miles N.N.W. ¹/₂ N. of Hirshals; 57°46' N., 9°44' E. — 32 meters. — Soft bottom. — No vegetation.
- bC. ⁶/₇ 07. Hirshals light-house S. ¹/₂ W. 12 miles. — 45 meters. — Soft bottom, ooze. — No vegetation.
- bE. ⁶/₇ 07. 6 miles N.E. by N. of Hirshals. — 23 meters. — Coarse sand. — No vegetation.
- bF. ⁶/₇ 07. Skagbanken; 9 miles N.E. by E. of Hirshals. — 16,5 meters. — Sand. — No vegetation.
- bB. ²/₇ 07. Skagens light-house E. 10 miles; Lat. N. 57°41', 5, Long. E. 10°20'. — 24 meters. — Stones and sand. — No vegetation.
- bG. ⁹/₇ 07. Northside of Skagens Gren, N.N.W. of Skagens light-house. — 5,5 to 17 meters. — Sand. — Few loose Algæ.
- ¹⁵/₈ 03. Between Gammel Skagen and the Siren, within the first shoal. — Small pebbles. — *Chorda Filum*, *Polysiphonia nigrescens*.

bG. ¹⁵/₈ 03. Between first and second shoal. — 3,5 to 4,5 meters. — Small pebbles. — *Polysiphonia nigrescens*, *Ceramium rubrum*.

¹⁶/₈ 03. Between Gammel Skagen and Højens light-house; between first and second shoal. — 3,5 to 5,5 meters. — Small stones. — Few Algæ, mostly species of *Polysiphonia*, (acorn-shells and young *Mytilus*).

Limfjord. (Lf)

ZS. ²⁵/₇ 05. Under the land at Kobbørød. — 2 to 4 meters. — Stones. — *Fucus serratus*.

ZV¹. ²⁶/₇ 05. In the middle of Nissum Bredning; the broom for Mullerne E. 2,5 miles. — 5 meters. — Soft bottom. — *Cladophora gracilis*. (*Ciona canina* in abundance).

ZV². — A little farther N.; the broom E. by S. ¹/₂ S. 2,5 miles. — (Small shells, *Ophioglypha albida*, often infested by a *Dactylococcus*).

LY. ²⁴/₈ 93. Between Gellerodde and Inderrøn near Lemvig. — 3 to 3,5 meters. — Sand with spots of loose *Furcellaria*, (*Cladophora*, *Phyllophora Brodiaei*).

M. ⁹/₉ 90. Søndre Røn near Lemvig. — 1 meter. — Stones. — *Fucus vesicul.*, here and there *Zostera*.

ZU. ²⁶/₇ 05. W. of the N. end of Rønne near Lem Vig. — 3 meters. — Stones. — *Fucus vesicul.* — Thereafter (northward) 4 meters — sand with *Ciona canina* and *Fucus serratus*.

LX. ²⁴/₈ 93. Rønne, a reef near Lem Vig. — Uppermost *Fucus vesicul.*; — 2 to 4 meters *Fucus serratus*; — 4 to 5,5 meters broad-leaved *Zostera*.

ZT. ²⁵/₇ 05. Off Østerbol. — about 4 meters. — *Zostera*, and a little farther out loose *Furcellaria* and *Cladophora gracilis* in great quantities.

XV. ¹⁹/₆ 01. N. of Rønne by Lem Vig. — Oysters, *Furcellaria*.

XX. ¹⁹/₆ 01. Midway between XV and Mullerne. — 5,5 meters. — *Furcellaria*, (*Cladophora gracilis*).

LZ. ²⁶/₈ 93. Off Røjens Odde. — 4 meters. — Clay-mud with a few stones. — No vegetation.

ZX. ²⁶/₇ 05. Immediately E. of the broom at Mullerne. — 6,5 meters. — Soft bottom. — *Cladophora gracilis*.

ZY. ²⁶/₇ 05. Nearer to land. — 4,5 meters. — Stones and soft bottom. — *Zostera*, *Fucus serratus*.

XY. ¹⁹/₆ 01. Near Mullerne. — 6,5 meters. — Soft bottom with stones. — *Fucus serratus*, (sparingly *Zostera*).

MA. ²⁶/₈ 93. Off Jestrup. — 5 meters. — Stones. — Scarcely any vegetation, only single specimens of *Fucus serratus*, *Chorda Filum* and *Desmarestia aculeata*.

LV. ²⁴/₈ 93. Off Nissum Huk. — 5,5 meters. — Clay-mud mixed with sand, with stones and oysters. — No plants.

LU. ²⁴/₈ 93. Off Kamstrup Røn. — Scarcely 7,5 meters. — Clay-mud without plants (a few *Cladophora gracilis*).

XU. ¹⁹/₆ 01. Immediately W. of Oddesund-Nord. — 4 meters. — Sand with single stones. — *Fucus serratus*, (*Halidrys*).

MB. ²⁶/₈ 93. S.W. of Oddesund-Nord. — 6,5 meters. — At first bare sand, then clay-mud with single Floridæ and, rather abundantly, loose *Cladophora gracilis*.

MD. ²⁶/₈ 93. Studemilen, right opposite Doverodde. — Thick *Zostera* vegetation everywhere; up on the bank also stones with *Fucus vesiculosus*.

ME. ²⁷/₈ 93. Off Skjoldborg (Thy), near the shoal. — 7,5 meters. — Soft bottom without vegetation.

- MF. ²⁷/₈ 93. Sundby Stengrund, at the N. side of Mors. — Stones. — *Chorda Filum*.
- MG. ²⁷/₈ 93. Stony reef by Hanklit. — *Fucus vesiculosus*, covered with *Melobesia*, *Lithophyllum pustulatum* and *Laurencia pinnatifida*. — Outside the reef *Zostera*.
- MH. ²⁸/₈ 93. Bank off Skrandrup, Thisted Bredning. — Stones. — *Fucus vesiculosus*, (*Chorda Filum*, *Corallina offic.*).
- I. ⁸/₉ 90. Venø Bugt, off Nørskov, Venø. — 3,5 meters. — Stony bottom with *Zostera*, (few Algæ, *Phyllophora membranif.*).
- K. ⁸/₉ 90. Venø Bugt, off Nørskov, Venø, N. of Venø Tap. — 4,5 to 5,5 meters. — *Furcellaria* and *Phylloph. membranif.*
- L. ⁸/₉ 90. Venø Bugt, Nygaards Hage. — 3,5 meters. — Stones. — *Zostera*, (*Furcellaria*, *Phyllophora membranif.*).
- XT. ¹⁹/₆ 01. South side of Jegindø Tap. — 4,5 meters. — Clay. — *Zostera*, (loose *Furcellaria*).
- MC. ²⁶/₈ 93. Jegindø Tap, immediately W. of the broom. — 6,5 meters. — Clay-mud without veg.
- MC¹. ²⁰/₈ 93. East side of Jegindø. — From shallow water to 4 meters depth *Zostera*, farther out clay-mud without vegetation.
- H. ⁶/₉ 90. Kaas Bredning, off Sillerslev, Mors. — 7,5 meters (?). — Clay-mud without vegetation.
- XN. ¹⁴/₇ 99. Sallingsund, immediately S. of Glyngøre. — 4 to 9 (?) meters. — Stones, oysters. — *Chorda Filum*, *Fucus vesiculosus*.
- XM. ¹³/₇ 99 and ²¹/₆ 06. Off Snabe. — 4 to 5,5 meters. — *Zostera* and stones with *Fucus vesiculosus*, *Chorda Filum* etc.
- XY¹. ²⁵/₆ 01. Vodstrup Hage (Skælholm) near Nykøbing. — Stones. — *Fucus vesic.*, *Rhodomela*, *Furcellaria* (loose).
- LT. ²²/₈ 93. Immediately outside the broom at Vodstrup Hage. — Ca. 5,5 meters. — Firm bottom with *Zostera*, (*Polysiphonia nigrescens*).
- LS. ²²/₈ 93. Off Alsted (Arnakke), Mors. — 5 meters. — Clay-mud with dead shells. — *Florideæ*, particularly *Polysiphonia nigrescens*.
- LS¹. — Nearer to land. — 1 to 3 meters. — Stones with *Fucus vesiculosus*; in some places also *Zostera*; farther out clay-mud with scarce *Florideæ*.
- aT. ²²/₆ 06. Outer part of Draaby Vig, off Alsted church. — 4 to 5,5 meters. — Soft bottom with *Zostera* and *Furcellaria*; in other places stones and oysters but few Algæ, farther out, 7,5 meters — soft bottom with shells, without vegetation.
- MF. ²⁸/₈ 93. Løgstør Bredning, off Ejerslev. — From land to 4 meters depth clayey sand with *Zostera*; in shallow water stones with *Fucus vesiculosus*.
- MK. ²⁸/₈ 93. Holmtunge Hage. — Stony reef with *Fucus vesiculosus*, here and there *Zostera*.
- LQ. ²²/₈ 93. Lendrup Røn. — Stones. — *Fucus vesiculosus*, (*Fucus serratus*, *Laurencia pinnatifida*).
- LR. ²²/₈ 93. E. of Livø. — 6,5 meters. — Soft bottom. — *Zostera*.
- F. ⁵/₉ 90. Skive Fjord, North side of Lundø Hage. — Ca. 5,5 meters. — Soft bottom. — No vegetation.
- F¹. — On the bank. — 3 meters. — *Zostera*, (a few loose *Furcellaria* and *Phyllophora Brodiaei*).
- G. ⁵/₉ 90. Off Skive. — 3,5 meters. — *Zostera* (a few loose *Furcellaria*). — On bare bottom loose clumps of *Furcellaria*, (*Phyllophora Brodiaei*, *Cladophora gracilis*).
- E. ⁴/₉ 90. Louns Bredning, W. of Trangmanden. — 5,5 meters. — Soft bottom. — Loose Algæ: *Cladophora gracilis*, (*Rhodomela*, *Phyllophora Brodiaei* etc.).
- E¹. — A little farther northwards. — Same depth and bottom, similar vegetation.

ML. ²⁹/₁₀ 93. Outside the broom near Klitgaard in Gjøl Bredning. — Thick broad-leaved *Zostera* vegetation with *Melobesia Lejolisii* and some *Ceramium rubrum*.

Kattegat, Northern part. (Kn)

- bH. ⁹/₇ 07. 8 miles S.E. by E. ¹/₂ E. of Skagen. — 30 meters. — Soft bottom. — No vegetation.
- FG. ¹³/₇ 92. Herthas Flak. — 19 to 22,5 meters. — Stones, gravel. — *Laminaria saccharina*, *Desmarestia aculeata*, (*Deless. sangvin.*, *Cystoclonium*).
- XI. ²⁹/₇ 96. Herthas Flak. — 20 to 22,5 meters. — Gravel and stones. — *Lamin. sacch.*, *Desmar. acul.*, *Deless. sangv.*, *Ceram. rubrum*, *Callithamnion corymbosum*, *Sporochnus*. (Vegetation spread).
- ¹⁴/₇ 05. — 20,5 to 24,5 meters. — The bottom alternately clay-mud and gravel with single stones; on these some few incrusting Algæ, for the rest nearly no vegetation (repeated dredgings).
- bI. ⁹/₇ 07. S.E. of Herthas Flak; 11 miles S.E. ¹/₄ S. of Skagen. — 26,5 meters. — Clay-mud. — No plants.
- IZ. ¹⁶/₅ 93. Skagens light-house N.N.W. ⁴/₅ W. a good 7 miles. — About 24,5 meters. — No vegetation (seine).
- IY. ¹⁵/₅ 93. Hirsholm light-house S.W. by S. a good 5 miles. — 22,5 meters. — Clay-mud. — No vegetation.
- KA. ¹⁵/₅ 93. Hirsholm light-house S. by E. ¹/₂ E. a good 5 miles. — 13 meters. — Fine sand. — scarce *Zostera* (seine).
- TV. ¹/₁₀ 04. Krageskovs Rev, northern shoal. — Stones and sand. — 5 meters. — Abundant vegetation: *Halidrys*, *Fucus serratus*, *Laminaria sacch.*, *Furcellaria*, (*Corallina* off.).
- KC. ¹⁵/₅ 93. Krageskovs Rev, southern shoal. — 4 to 5,5 meters. — Stones. — Abundant vegetation: *Halidrys*, *Fucus serratus*, *Laminaria digitata*.
- KB. ¹⁵/₅ 93. Off Snedkergaarde. — 4,5 meters. — Fine bare sand with only a few spots most probably of *Zostera*.
- TX. ²/₁₀ 94. Inside the broom N. of Græsholm (Hirsholmene). — 7,5 to 9,5 meters. — Stones. — Dense vegetation: *Halidrys*, *Fucus serratus*, *Laminaria hyperborea*.
- ⁵/₁ 95 and ²⁴/₇ 95. Same vegetation; of predominant species further *Laminaria digitata* and *saccharina*, *Furcellaria*.
- YR. ³¹/₇ 02. Naamands Rev N. of Græsholm. — Stones. — *Halidrys*, *Laminaria digitata*.
- XK. ⁴/₇ 99. N.E. of Græsholm. — 7,5 to 11,5 meters. — Stones. — *Laminaria hyperborea*...
- YS¹. ³¹/₇ 02. E. of the broom N. of Græsholm. — Ca. 9 meters (?). — Soft bottom. — No vegetation.
- YS². ³¹/₇ 02. The broom N. of Græsholm W.S.W. ca. 1 mile. — 15 meters. — Clay-mud with snails etc. — On the snail-shells some Algæ (*Antithamnion*, *Polysiphonia atrorubescens*, *P. elongata* a. o.).
- YX. ¹¹/₇ 04. E. of the broom at N.E. reef by Hirsholm. — 22,5 to 28 meters. — Soft bottom. — On mollusc shells: *Polysiphonia atrorubescens*, *P. elongata* a. o. Algæ.
- TU. ¹/₁₀ 94 and ⁵/₁ 95. At the broom at N.E. reef by Hirsholm. — ca. 9,5 meters. — Sand and stones. — *Laminaria saccharina*, (*Desmarestia aculeata*, *Laminaria hyperborea*).
- ¹¹/₇ 04. Same place, but within the broom. — 7,5 to 9,5 meters. — Stones. — *Laminaria hyperborea*, *L. sacchar.*, *Furcellaria* a. o. *Floridæ*.

- TU. ¹¹/₇ 04. Outer side of the same reef. — 9,5 to 11,5 meters. — Soft bottom and gravel (?). — *Stictyosiphon*, *Striaria* a. o.
- NF. ²¹/₉ 93. Immediately outside the harbour of Hirsholm. — 4 meters. — Sand. — *Zostera*.
- TY. ²/₁₀ 94.. The bank S. of Hirsholm. — 7,5 meters. — Sand and single stones. — Scattered *Zostera*.
- NE. ²¹/₉ 93. Off Lerbæk. — 5,5 meters. — Gravel. — *Zostera*.
- YQ. ²⁵/₇ 02. E. side of Kølpen. — 2 to 5,5 meters. — Stones. — Abundant algal vegetation: *Fucus vesicul.*, *F. serratus*, *Chorda Filum*, *Halidrys*, *Laminaria sacchar.*, *L. digit.*...
- XG. ²/₈ 95. E. of Deget. — 4 to 5,5 meters. — Stones. — *Halidrys*, *Fucus serr.*, *Florideæ*, (*Laminaria hyperb.*).
- GO. ²³/₁₀ 92. Outside Busserev near Frederikshavn. — 3 meters and more. — Stones. — *Fucus serratus*, *Halidrys*, (*Laminaria digitata*).
- UD. ⁵/₁ 95. Marens Rev. — 4,5 to 5,5 meters. — Stones. — *Halidrys*, (*Laminaria digit.*, *sacchar.*, *Fuc. serr.*).
- XH. ⁹/₇ 96. The beacon buoy at Marens Rev W. by S. ca. 1 mile. — 15 meters. — Clay-mud with snails (*Turritella*, *Aporrhais*). — On the shells *Polysiphonia atrorubescens*.
- XL. ⁸/₇ 99.. The buoy at Marens Rev W. by N. a good 1,5 miles. — 19 to 20,5 meters. — Clay-mud. On *Aporrhais* and *Turritella*: *Polysiphonia atrorubescens*, *Stictyosiphon tortilis*, *Antithamnion*, *Sphacelaria*.
- FH. ¹⁵/₇ 92. Borrebjergs Rev, near the triple broom. — 4 to 7,5 meters. — Sand. — *Zostera*.
- YP¹. ²⁵/₇ 02. Outside Laurs Rev. — Stones. — *Halidrys* (with *Ectocarpus*).
- YP². ²⁵/₇ 02. Borrebjergs Rev. — Stones. — *Halidrys*, (*Laminaria digitata* and *sacchar.*).
- YP³. ²⁵/₇ 02. Laurs Rev. — Stones. — *Halidrys*, *Lamin. digit.*, *hyperb.* and *sacchar.*
- TZ. ³/₁ 95. Between Borrebjergs Rev and Laurs Rev. — No vegetation.
- YO. ²⁰/₇ 02. 1 mile S.E. of Laurs Rev. — Soft bottom. — Dead *Zostera*-leaves.
- ¹³/₇ 05. In the deep channel N.W. of Læsø. — Soft bottom. — No Algæ.
- BP. ²⁴/₈ 91. Off Sæby. — 7 meters. — Firm clayey sand. — In spots *Zostera*.
- TM. ²⁷/₉ 94. Nordre Rønners light-house S.E. by S. 2,6 miles. — 13 meters. — Sand without vegetation.
- VT. ³/₇ 95. Nordre Rønners light-house S. scarcely 2,5 miles. — 9,5 meters. — Sand. — *Zostera*, *Fucus serratus*, *Florideæ*, (*Laminaria sacchar.*).
- UA. ³/₁ 95. Nordre Rønners light-house S. scarcely 2 miles. — 11,5 meters. — No plants.
- TI. ²⁶/₉ 94. Nordre Rønners light-house E. S. E. scarcely 1,5 miles. — 12,5 meters. — Firm clay with stones. — *Laminaria sacchar.*, *Desmarestia acul.* a. o. (vegetation not abundant).
- TL. ²⁷/₉ 94. Nordre Rønners light-house E. by N. ¹/₄ N. ¹/₃ miles. — 7,5 meters. — Stones. — Rich vegetation: *Fucus serratus* and *Florideæ*.
- — Nearer to the reef. — 4 to 5,5 meters. — Sand with stones. — Alternately sand without vegetation or with scarce *Zostera*, or stony bottom with various Algæ.
- TK. ²⁶/₉ 94. Nordre Rønners light-house E. by N. ²/₃ miles. — 9,5 meters. — Sand. — *Zostera*.
- KD. ¹⁵/₅ 93. At the beacon-buoy at Nordvestrevet, Læsø. — 11,5 to 22,5 meters. — Sand to sandy clay-mud. — No vegetation.
- ZP. ¹⁵/₇ 05. The broom N.E. of Nordre Rønner S. ¹/₂ E. 1 mile. — 11,5 meters. — Sand with stones. — *Zostera*, *Halidrys*, (scarce *Fucus serratus*).
- NG. ²¹/₉ 93. N. of Nordre Rønner. — 4 meters. — Stones. — Abundant vegetation: *Halidrys*, *Fucus serratus*, (*Laminaria digitata*, *Fucus vesiculosus*).

- UC. ³/₁ 95. At the broom N.E. of Nordre Rønner. — ca. 9,5 meters. — Stones. — *Halidrys*, *Fucus serratus*, (*Florideæ*, *Laminaria digitata*).
- VU. ³/₇ 95. Nordre Rønners light-house S.W. by W. ³/₄ W. 2,5 miles. — 15 meters. — Stones. — *Halidrys*, *Cruoria*.
- GL. ²¹/₉ 92. ¹/₂ mile E. of the broom at Nordre Rønner. — 9,5 meters. — Sand without vegetation.
- GN. ²¹/₉ 92. Anchoring ground at the E. side of Nordre Rønner. — Ca. 4 to 5 meters. — Stones. — *Fucus serratus*, (*Halidrys*, *Laminaria digitata* and *sacchar.*).
- UB. ³/₁ 95. Nordre Rønners light-house W.N.W. ²/₃ to ³/₂ miles. — Here and there stones. — *Halidrys*, *Fucus serratus*, *Florideæ* mostly *Furcellaria* and *Corallina*, (*Zostera*).
- TH. ²⁶/₉ 94. Nordre Rønners light-house W.N.W. ¹/₄ N. a good 3 miles. — 10,5 meters. — Sand. — *Fucus serratus*, (*Florideæ*, *Zostera*).
- ZL. ⁵/₇ 05. 3 miles S.E. by E. of Nordre Rønner. — 6,5 meters. — Sand with stones. — *Fucus serratus*, (*Fuc. vesiculosus*, *Halidrys*).
- ZL¹. — Near the preceding. — 9,5 meters. — Similar vegetation but moreover *Zostera* and *Desmarestia acul.*
- ZL². — Near the preceding. — 11,5 meters. — Stones. — Similar vegetation, in abundance *Furcellaria* and *Corallina* off.
- TN. ²⁷/₉ 94. Trindelen light-ship E.S.E. ⁵/₃ miles. — 12 meters. — Sand. — No vegetation.
- NH. ²¹/₉ 93. Trindelen light-ship E. ⁵/₂ miles. — 15 meters. — Gravel. — Almost no vegetation.
- ZM. ⁵/₇ 05. Ca. ⁴/₂ miles E. ³/₄ N. of Nordre Rønner. — 15 meters. — Gravel and small pebbles. — Almost no Algæ.
- IX. ¹²/₅ 93. Trindelen light-ship N.E. ²/₃ E. 4 miles. — ca. 19 meters (in the channel). — *Desmarestia acul.*, *Laminaria sacch.*, (*Halidrys*).
- GM. ²¹/₉ 92. At Engelskmands Banke. — Ca. 5,5 meters. — Stones. — *Fucus serratus*, *Chorda Filum*, *Florideæ* (*Phyllophora*).
- ³/₇ 95. Stony reef by Jegens Odde. — 2 to 4 meters. — *Fucus serratus* with *Polysiphonia violacea*, *Halidrys*. — On a dry rock particularly *Chordaria flagelliformis*, *Ahnfeltia*, *Spermothamnion*, *Chondrus*.
- TG. ²⁶/₉ 94. Syrodde Pynt (Læsø) S.S.E. ¹/₂ miles. — 9,5 meters. — Sand. — *Halidrys*, *Fucus serratus*, *Florideæ*, mostly *Furcellaria*, (*Zostera*).
- TO. ²⁷/₉ 94. Tønneberg Banke; Trindelen light-ship S. ²/₂ miles. — 18 meters. — Stones. — *Laminaria saccharina* (large specimens) and *Florideæ*.
- TP. ²⁷/₉ 94. Tønneberg Banke; Trindelen light-ship S.S.W. ¹/₂ W. ²/₂ miles. — 16 meters. — Sand (?) with stones. — *Florideæ*, *Halidrys*, *Laminaria saccharina*.
- ZA. ²⁶/₇ 04. Tønneberg Banke; Trindelen light-ship S.W. by S. 2 miles. — 12 to 18 meters. — Stones. — *Desmarestia aculeata*, *Halidrys*, *Brongniartella*, *Fucus serratus*, later *Laminaria sacchar.*
- YZ. ²⁶/₇ 04. Kummel Banke; Trindelen light-ship S.W. by W. ³/₄ W. ³/₄ miles. — 38 meters. — Clay. — No Algæ.
- NK. ²¹/₉ 93. Kummel Banke. — 28 to 30 meters. — Gravel. — No vegetation.
- ZB. ²⁶/₇ 04. Trindelens light-ship W. by S. ³/₄ S. ²/₂ miles. — 28 to 30 meters. — Gravel, shells. — *Lithothamnion calcareum*, *Corallina offic.*, *Furcellaria*, *Rhodomela*.
- FF. ¹³/₇ 92. Double broom at Trindelen S. by W. ¹/₂ W. ¹/₂ mile. — 15 meters. — Stones. — *Halidrys*, *Laminaria sacchar.*, (*Florideæ*).

- FE. ¹³/₇ 92. Trindelen, immediately E. of the double broom. — 9,5 to 11,5 meters. — Stones. — *Fucus serratus*, (*Laminaria*, *Furcellaria*).
- NI. ²¹/₉ 93. Trindelen. — 9,5 to 10,5 meters. — Stones. — *Halidrys*, *Fucus serratus*, *Floridææ*; abundant vegetation.
- TQ. ²⁷/₉ 94. At Trindelen light-ship. — Stones, mostly rather small. — Incrusting Algæ, e. gr. *Lithoderma*, *Cruoriella Dubyi*, (other Algæ scarce).
- TR. ²⁷/₉ 94. Trindelen light-ship N.W. $1\frac{1}{4}$ miles. — 23,5 meters. — Stones. — Incrusting Algæ e. gr. *Lithoderma*, *Cruoria pellita*, *Aglaozonia* . . ., (*Desmarestia acul.*, *Laminaria sacch.*).
- IV. ¹²/₅ 93. Triple broom S. of Trindelen E. by S. $\frac{1}{2}$ mile. — Ca. 11 meters. — Sand. — No vegetation.
- VV. ³/₇ 95. E. of the triple broom S. of Trindelen. — 32 to 36 meters. — Clay-mud (?). — No vegetation.
- VX. ³/₇ 95. Bøchers Banke. — 29 meters. — Gravel. — Almost no Algæ (scarce *Laminaria sacch.*, *Desmarestia acul.*, *Odonthalia*).

Kattegat, eastern part. (Ke)

- FD. ¹³/₇ 92. E. of Flyndergrund, E. of Læsø, Lat. N. $57^{\circ}16'25''$, Long. E. $11^{\circ}15''$. — 9,5 to 11,5 meters. — Dark sand. — In spots *Zostera*.
- FC. ¹³/₇ 92. E. of Flyndergrund, Lat. N. $57^{\circ}16'10''$, Long. E. $11^{\circ}16'6''$. — 17 to 18 meters. — Soft bottom. — Molluscs with single Algæ.
- FB. ¹³/₇ 92. E. of Flyndergrund, Lat. N. $57^{\circ}15'45''$, Long. E. $11^{\circ}18'$. — 30 to 36 meters. — No vegetation.
- EY. ¹²/₇ 92. Kobbergrundens light-ship E. by S. $\frac{4}{5}$ mile. — 13 meters. — Fine sand. — No plants.
- ZH. ²⁹/₇ 04. North end of Groves Flak; Kobbergrundens light-ship W. $\frac{1}{2}$ S. $6\frac{3}{4}$ miles (?). — 32 meters. — Soft bottom, partly firm clay, also pebbles. — Scarce vegetation: *Laminaria sacch.*, single *Delesseria sinuosa*.
- ZI. ²⁹/₇ 04. North end of Groves Flak; Kobbergrundens light-ship W. $4\frac{2}{3}$ miles. — 26,5 meters. — Stones and gravel, shells. — Almost no Algæ.
- EX. ¹²/₇ 92. Groves Flak, Lat. N. $57^{\circ}7'30''$, Long. E. $11^{\circ}31'40''$. — 26,5 meters. — Sand. — Scarce algal vegetation.
- VZ. ⁵/₇ 95. Groves Flak, Lat. N. $57^{\circ}6'18''$, Long. E. $11^{\circ}32'40''$. — 24,5 meters. — Gravel and stones. — Incrusting Algæ: *Cruoria pellita*, *Cruoriella Dubyi* (*Lamin. sacch.* overgrown with *Membranipora*, *Desmarestia aculeata*).
- IR. ¹²/₅ 93. Groves Flak; Kobbergrundens light-ship N.W. by W. a good 8 miles. — 24,5 meters. — Stones. — *Cruoria pellita*, (*Desmarestia acul.*).
- IS. ¹²/₅ 93. Groves Flak; Kobbergrundens lightship N.W. a good 7 miles. — 22,5 meters. — Sand. — *Desmarestia aculeata*, (*Laminaria sacch.*).
- IT. ¹²/₅ 93. Groves Flak, S.W. border; Kobbergrundens light-ship N.W. $\frac{1}{2}$ N. 7 miles. — 24,5 meters. — *Desmarestia acul.*, *Deless. sanguin.* (trawl).
- IU. ¹²/₅ 93. Same place. — 30 to 38 meters (seine). — *Desmarestia acul.*, (*Delesseria sanguin.*).
- EV. ¹²/₇ 92. South end of Groves Flak, Lat. N. $57^{\circ}4'50''$, Long. E. $11^{\circ}35'$. — 22,5 meters. — Stones. — *Laminaria sacch.*, (*Lamin. digit.*, *Desmarestia acul.* and *viridis*, *Floridææ*).
- IL. ¹²/₅ 93. Fladen, Nidingen N.E. $\frac{1}{2}$ N. a good 4 miles. — 24,5 meters. — Stones and gravel. — *Lithothamnium*, (*Laminaria sacchar.*, *digit.*, *Desmarestia aculeata*).

- IL¹. ¹²/₅ 93. Fladen, Nidingen N.E. $4\frac{2}{3}$ miles. — 28 meters. — Gravel and stones. — *Lithothamnium*, (*Laminaria*, *Odonthalia*).
- IM. ¹²/₅ 93. Fladen, Lat. N. $57^{\circ}12'50''$, Long. E. $11^{\circ}47'$. — 16 meters. — Gravel. — *Halidrys*, *Desmarestia acul.*, *Laminaria sacch.*
- ZG. ²⁸/₇ 04. Fladens light-ship S.E. by S. a good 2 miles. — 18 meters. — Stones. — *Halidrys*, *Florideæ*, *Laminaria hyperb.*, *Desmar. acul.*, *Corallina off.*
- VY. ⁵/₇ 95. Fladen, Lat. N. $57^{\circ}11'22''$, Long. E. $11^{\circ}44'$. — 18 meters. — Sand with stones. — Vegetation not abundant: *Halidrys*, *Desmarestia acul.*, *Polysiphonia elongata*.
- IN. ¹²/₅ 93. Fladen, Lat. N. $57^{\circ}11'10''$, Long. E. $11^{\circ}45'$. — 15 meters. — Gravel, stones, — *Fucus serratus*, *Halidrys*, *Desmar. acul.*
- IO. ¹²/₅ 93. Fladen, Lat. N. $57^{\circ}10'40''$, Long. E. $11^{\circ}44'40''$. — 10,5 to 11,5 meters. — Stones. — *Fucus serratus*, *Halidrys*.
- ZF. ²⁸/₇ 04. Fladens light-ship S. by E. a good mile. — 22,5 meters. — Stones. — The three species of *Laminaria*, particularly *L. digitata*, various *Florideæ*.
- ZE. ²⁸/₇ 04. Immediately W. of Fladens light-ship. — 26,5 meters. — Stones. — *Laminaria digit.*, *sacch.*, *Fucus serratus*, a few *Florideæ*.
- ZE¹. ²⁸/₇ 04. Fladens light-ship S.E. by E. $\frac{1}{6}$ mile. — 19 meters. — Stones. — *Laminaria* 3 species, various *Florideæ* e. gr. *Odonthalia*.
— Fladens light-ship S.E. by E. $\frac{1}{8}$ mile. — 15 meters. — Stones. — *Florideæ*, mostly *Furcellaria*, *Halidrys*, *Fucus serratus*.
- IP. ¹²/₅ 93. W. side of Fladen, Lat. N. $57^{\circ}10'$, Long. E. $11^{\circ}41'20''$. — Ca. 21 meters. — Stones. — *Desmarestia acul.*, (*Lamin. sacchar.*, *Lithothamnium*, *Halidrys*).
- IQ. ¹²/₅ 93. W. side of Fladen, Lat. N. $57^{\circ}9'30''$, Long. E. $11^{\circ}41'40''$. — 21,5 to 30 meters. — Stones. — *Laminaria sacch.*
— — — 30 to 38 meters. (seine). — Incrusting Algæ, *Desmarestia aculeata*.
- XA. ⁵/₇ 95. Kobbergrundens light-ship N. by W. $\frac{1}{2}$ W. a good $6\frac{1}{2}$ miles. — 13 meters. — Gravel with stones, shells. — Scarce vegetation: *Halidrys*, *Chorda Filum*, various *Florideæ*.
- IK. ¹⁰/₅ 93. Lille Middelgrund, the beacon S.W. by W. $1\frac{2}{3}$ miles. — 17 to 19 meters. — Gravel. — *Lithothamnium*.
- II. ¹⁰/₅ 93. Lille Middelgrund, the beacon S.E. by S. $\frac{1}{2}$ S. $\frac{5}{6}$ mile. — 14 meters. — Stones. — *Fucus serratus*, (*Furcellaria*).
- EU. ¹²/₇ 92. Lille Middelgrund, Lat. N. $56^{\circ}56'28''$, Long. E. $11^{\circ}51'52''$. — 14 meters. — Gravel with stones. — *Corallina offic.*, (*Halidrys*, *Chorda Filum*, *Lithothamnium Lenormandi*).
- ET. ¹²/₇ 92. Lille Middelgrund, Lat. N. $56^{\circ}56'25''$, Long. E. $11^{\circ}52'40''$. — 12 meters. — Stones, gravel. — *Fucus serratus*.
- ES. ¹²/₇ 92. S.W. of Lille Middelgrund. — 24,5 meters. — Coarse brown sand. — No vegetation (1 specimen of *Laminaria sacchar.*).
- IH. ¹⁰/₅ 93. The beacon at Lille Middelgrund N.W. by N. $\frac{1}{2}$ N. a good 4 miles. — 20 to 28 meters. — Stones and gravel. — *Lithothamnium*, (*Laminaria sacchar.*, *Desmarestia acul.*).
- IG. ¹⁰/₅ 93. The beacon at Lille Middelgrund N.W. $\frac{4}{5}$ N. 6 miles. — 36 meters. — Sand and clay-mud. — No vegetation.
- ER. ¹²/₇ 92. Fyrbanken, the beacon at Anholt Knob S. by W. $1\frac{5}{6}$ miles. — 28 meters. — Sand with stones. — Scarce algal vegetation, (mostly *Desmarestia viridis*).
- EQ. ¹²/₇ 92. At the beacon at Anholt Knob. — 9,5 to 16 meters. — Scarce algal vegetation.

- IF. ¹⁰/₁₅ 93. Røde Banke, the beacon at Anholt Knob N.W. by W. ¹/₂ W. 8 miles. — 31 meters. — Red clayey sand. — No vegetation.
- IE. ¹⁰/₁₅ 93. Near Røde Banke, Anholt Knobs light-ship N.W. 7 miles. — 34 to 36 meters. — No vegetation.
- RU. ¹/₈ 94. Tylø light-house E. S. E. ¹/₂ E. scarcely 9 miles. — 26,5 meters. — Clay-mud. — Scarce *Florideæ*.
- RV. ¹/₈ 94. Tylø light-house S. E. ¹/₂ S. 5 ¹/₂ miles. — 20,5 meters. — Stones. — Nearly no Algæ.
- RT. ¹/₈ 94. Store Middelgrund, Lat. N. 56°37,5', Long. E. 12°4,5'. — 24,5 meters. — Sand. — No vegetation.
- ID. ¹⁰/₁₅ 93. Store Middelgrund, Lat. N. 56°34,5', Long. E. 12°5,5'. — 19 meters. — Stones. — *Corallina offic.*
- IC. ¹⁰/₁₅ 93. Store Middelgrund, Lat. N. 56°33'20'', Long. E. 12°5'10''. — 10,5 meters. — Stones. — *Fucus serratus*, (*Furcellaria*).
- IB. ¹⁰/₁₅ 93. Store Middelgrund, Lat. N. 56°33', Long. E. 12°5'. — 11,5 to 13 meters. — *Fucus serratus*, *Halidrys*, *Furcellaria*, *Laminaria digitata*.
- IA. ¹⁰/₁₅ 93. Store Middelgrund, Lat. N. 56°32'50'', Long. E. 12°5'20''. — 11,5 to 13,5 meters (trawl). — *Fucus serratus*.
- ¹²/₇ 07. Nearly in the same place. — Stones with incrusting Algæ, *Cruoria pellita*, *Lithothamnium*, and *Delesseria sanguinea*, *Desmarestia acul.*, *D. viridis*, *Corallina offic.*
- HX. ¹⁰/₁₅ 93. Store Middelgrund, south side, Lat. N. 56°32'30'', Long. E. 12°3'40''. — 17 meters. — Stones. — *Fucus serratus*, *Halidrys*, *Corallina offic.*
- HY. ¹⁰/₁₅ 93. Store Middelgrund, south side, Lat. N. 56°32'20'', Long. E. 12°5'20''. — 15 meters. — Reddish gravel. — *Fucus serratus*.
- HZ. ¹⁰/₁₅ 93. Store Middelgrund, south side, Lat. N. 56°32', Long. E. 12°5'40''. — 25,5 meters. — Few Algæ.
- GI. ²¹/₇ 92. Ostindiefarer Grund. — 4 to 8,5 meters. — Stones. — 4,5 meters: *Halidrys*, *Laminaria digitata*, *Fucus serratus*, *Florideæ*. — 4 to 7,5 meters: *Florideæ*, mostly *Phyllophora membranifolia*, *Furcellaria*, (*Fucus serratus*).
- OO. ¹⁸/₄ 94. Søborghoved Grund. — 8,5 meters. — Stones. — *Fucus serratus*, *Halidrys*, *Phylloph. membranif.*, (*Phylloph. Brodiaei*, *Lithothamnium*, *Corallina offic.*, *Laminaria digit.*, *sacchar.*).

Kattegat, central Part. (Km)

- TT. ¹/₁₀ 94. W. of Dvalegrunde, Læsø Rendes light-ship S. E. ¹/₂ E. 2 ²/₃ miles. — 7,5 meters. — Coarse sand. — *Zostera*.
- FI. ¹⁵/₇ 92. Dvalegrund, by the double broom. — 4,5 meters. — Sand with shells. — No Algæ.
- BO. ²⁴/₈ 91. By the broom at Stensnæs. — 5,5 meters. — Sand. — Narrow-leaved *Zostera*.
- BN. ²⁴/₈ 91. Asaa W. by N., the broom at Stensnæs N. N. E. — Ca. 9,5 meters. — Sandy clay-mud. — Scarce vegetation: *Halidrys*, (*Polysiphonia nigresc.*).
- TS. ¹/₁₀ 94. Off Hov, Lat. N. 57°2 ¹/₂', Long. E. 10°27'. — 7,5 meters. — Clayey sand with few stones. — *Zostera*, *Halidrys*, *Corallina offic.*
- VQ. ²/₇ 95. Svitringen, Lat. N. 57°, Long. E. 10°35'. — 11,5 meters. — Sand. — Scarce *Zostera*.
- VS. ²/₇ 95. Læsø Rende, Ryggen, the light-ship S. W. ¹/₂ S. 2 ³/₄ miles. — 18 meters. — Sand. — No vegetation.
- KE. ¹⁵/₅ 93. By the broom at Søndre Rønners Flak. — 7,5 meters. — Sand without vegetation.

- VR. $\frac{2}{7}$ 95. Læsø Rendes light-ship N.W. by N. $\frac{1}{2}$ N. $3\frac{3}{4}$ miles. — 20,5 meters. — Soft bottom without vegetation.
- XF. $\frac{5}{7}$ 95. Søndre Rønners beacon E.N.E. 4 miles. — 8,5 meters. — Sand with few stones. — *Zostera* with *Fucus serratus*, (*Ahnfeltia*, *Corallina offic.*, *Cystoclonium*).
- KF. $\frac{15}{5}$ 93. Læsø Rendes light-ship N.W. by N. $\frac{1}{5}$ N. a good 14 miles. — 6,5 meters. — Sand with pebbles. — *Fucus serratus*, very broad, (*Fuc. vesiculosus*, *Zostera*).
- XE. $\frac{5}{7}$ 95. Near the broom at Silderøn. — Mostly 2 to 4 meters. — Sand. — *Zostera*, (*Fucus serratus*).
- FA. $\frac{12}{7}$ 92. E.S.E. of Hornfiskerøn, S. side of Læsø. — Within $\frac{1}{2}$ meter line bare sand, outside this line *Zostera*-vegetation.
- EZ. $\frac{12}{7}$ 92. W. of Mellemflak, S. of Læsø. — 4 meters. — Sand. — *Zostera*.
- YY. $\frac{23}{7}$ 04. From the broom at the N. end of Kobbergrund northwards. — 4,5 meters. — First bare sand, later single stones with *Fucus serratus*.
- ZC. $\frac{27}{7}$ 04. The broom at the N. end of Kobbergrund N.E. 1,5 miles. — 4 to 4,5 meters. — Sand. — *Zostera* in spots, with various Algæ, *Fucus serratus*.
- ZC¹. $\frac{27}{7}$ 04. Inside Kobbergrund. — 5 meters. — Sand. — *Chorda Filum*, *Spermatocnusus*.
- ZD. $\frac{27}{7}$ 04. Kobbergrundens light-ship E.S.E. 4 miles. — 7,5 meters. — Sand. — *Zostera* with *Fucus serratus*, large, broad plants.
- XD. $\frac{5}{7}$ 95. The broom at Silderøn, N. $\frac{3}{4}$ W. nearly 8 miles. — 9,5 meters. — Sand. — *Zostera* (with *Fucus serratus*).
- XB. $\frac{5}{7}$ 95. Kobbergrundens light-ship N. $\frac{3}{4}$ E. $8\frac{3}{4}$ miles. — 12 meters. — Stones. — *Fucus serratus*, *Furcellaria* a. o. *Florideæ*.
- BM. $\frac{23}{8}$ 91. The broom at Muldbjerg Grund W. $\frac{2}{3}$ N. a good 2 miles. — 8,5 meters. — Sand (?) with stones. — *Zostera* and *Halidrys*.
- VP. $\frac{2}{7}$ 95. The broom at Muldbjerg Grund N.N.W. $\frac{1}{3}$ N. $5\frac{1}{2}$ miles. — 7,5 meters. — Fine sand. — Scarce *Zostera*.
- BL. $\frac{23}{8}$ 91. Mariager Fjord S.W. by W. $\frac{3}{4}$ W., Muldbjergene N.W. $\frac{3}{4}$ N. — 9,5 meters. — Sand. — *Zostera*.
- VO. $\frac{2}{7}$ 95. Off Stevn in Mariager Fjord. — Mud with *Mytilus*, scarce *Ceramium rubrum*.
- VN. $\frac{1}{7}$ 95. The buoy at the mouth of Randers Fjord N.W. $3\frac{1}{3}$ miles. — 8,5 meters. — Sand. — Loose *Furcellaria* in abundance, very scarce *Zostera*.
- VM. $\frac{1}{7}$ 95. The buoy at Tangen N.E. $\frac{2}{3}$ E. $4\frac{1}{4}$ miles. — 8 meters. — Sand. — Loose *Furcellaria* in abundance.
- BK. $\frac{23}{8}$ 91. By the buoy at Tangen. — 7 meters. — Coarse sand with stones. — *Zostera*, rather narrow-leaved with broad *Fucus serratus*, (*Furcellaria*).
- VL. $\frac{1}{7}$ 95. The buoy at Tangen N.N.W. $5\frac{1}{2}$ miles. — 10,5 meters. — Sand. — Dead *Zostera*-leaves, loose *Furcellaria*.
- NC. $\frac{19}{9}$ 93. E. of Tangen, Fornæs light-house S. $\frac{1}{4}$ W. 7 miles. — 8,5 meters. — Sand with stones. — *Fucus serratus*, *Laminaria digitata*, *Furcellaria*, *Corallina offic.*
- BI. $\frac{23}{8}$ 91. Gjerrild Flak; Fornæs light-house S. by E. $\frac{1}{3}$ E. a good 6 miles. — 7,5 meters. — Sand with sparse spots of *Zostera*, (*Furcellaria*).
- BH. $\frac{23}{8}$ 91. Off Gjerrild Klint, $\frac{1}{2}$ mile from land. — 7,5 meters. — Bare sand with spots of vegetation: *Zostera* and *Furcellaria*, (*Fucus serratus*).
- VK. $\frac{1}{7}$ 95. Fornæs light-house S. $\frac{1}{2}$ W. $2\frac{2}{3}$ miles. — 12 meters. — Pebbles. — A clump of *Halidrys*.

- VK¹. ¹/₇ 95. ²/₃ mile W. by N. of VK. — 10,5 meters. — Sand and pebbles. — No vegetation.
- FK. ¹⁵/₇ 92. Aalborg Bugt, Lat. N. 56°56,5', Long. E. 10°45,5'. — 12 to 13 meters. — Sand. — No vegetation.
- FL. ¹⁵/₇ 92. Lat. N. 56°56,5', Long. E. 10°46,8'. — 9,5 meters. — Sand, alternately bare and covered with *Zostera*.
- FM. ¹⁵/₇ 92. The buoy at Tangen W. by S. ¹/₂ S. a good 8 miles. — 13 meters. — Sand, shells. — No vegetation, only single specimens of *Corallina offic.*
- FN. ¹⁵/₇ 92. Fornæs light-house S. ¹/₂ W. nearly 14 miles. — 12 meters. — Sand with stones. — *Halidrys*.
- ND. ¹⁹/₉ 93. Fornæs light-house S. by W. ¹/₂ W. 11³/₄ miles. — 11,5 to 13 meters. — Sand with single stones. — Very scarce vegetation: *Lithothamnion*, *Halidrys*.
- HT. ⁹/₅ 93. Fornæs light-house S.W. ⁵/₈ W. 7 miles. — 16 meters. — Sand and pebbles. — No vegetation.
- HU. ⁹/₅ 93. Fornæs light-house S.W. by W. ¹/₄ W. nearly 13 miles. — 17 meters. — Sand with stones. — No vegetation.
- XC. ⁵/₇ 95. The double broom at the end of Anholt Nordvest Rev S.S.E. ¹/₂ E. 11 miles. — 11,5 meters. — Gravel with stones. — *Halidrys*.
- bK. ¹²/₇ 07. 15 miles N.W. by W. ¹/₂ W. of Anholt light-house. — 15 meters. — Stones. — Very few Algæ (*Polysiphonia elong.*, *Desmarestia viridis*).
- bL. ¹²/₇ 07. 13 miles W. by N. ¹/₄ N. of Anholt light-house. — 19 meters. — Sand. — No vegetation.
- KF¹. ¹⁶/₅ 93. Anholt Nordvest Rev, 2 miles of the broom. On the reef and on both sides of it bare sand.
- KF². ¹⁶/₅ 93. N. of Anholt, E. of Nordvest Rev. — Ca. 8 to 13 meters. — Bare sand, here and there spots of loose *Furcellaria* partly mixed with *Polyides*.
- KG. ¹⁶/₅ 93. W. of the double broom by Rønneløbet by Anholt. — 4,5 meters. — Sand with stones. — *Fucus serratus*.
- HV. ⁹/₅ 93. Anholt light-house N.E. by E. ¹/₆ E. 7¹/₂ miles. — 5,5 to 7,5 meters. — Sand. — No vegetation.

Kattegat, southern part. (Ks)

- RQ. ³¹/₇ 94. Fornæs light-house W. ¹/₄ S. 1 mile. — 17 meters. — Coarse sand. — Almost no vegetation.
- FO. ¹⁵/₇ 92. Off Havknude. — 5,5 to 6,5 meters. — Sand. — Very scarce vegetation (*Fucus serratus*, *Florideæ*).
- NB. ¹⁸/₉ 93. Havknudeflak. — 7,5 to 8,5 meters. — Sand with stones. — Vegetation in spots: *Furcellaria*, (*Fucus serratus*, *Brongniartella*, *Zostera*).
- FP. ¹⁵/₇ 92. Jessens Grund, by the buoy. — 4 meters. — Stones. — *Fucus serratus*, (*Laminaria digitata*, *Florideæ*, *Halidrys*).
- NA. ¹⁸/₉ 93. Hjelm light-house S.W. by S. ¹/₄ S. 5¹/₄ miles. — 17 to 18 meters. — Fine gravel. — No plants.
- KH. ¹⁷/₅ 93. The broom at Jessens Grund N.N.W. ¹/₄ W. 3¹/₂ miles. — 18 meters. — Stones. — No vegetation.
- MZ. ¹⁸/₉ 93. Hjelm light-house S. by E. 2 miles. — 10,5 to 13 meters. — Gravel (?) with stones. — *Chorda Filum*, (*Corallina offic.*).

- BG. ²¹/₈ 91. 1¹/₃ miles N. by E. ¹/₂ E. (?) of Hjelm light-house. — 38 meters. — No vegetation.
- EP. ¹²/₇ 92. Pakhusbugt by Anholt. — 19 meters. — Sand. — Loose *Furcellaria*.
- ZN. ¹⁰/₇ 05. Anholt light-house N.E. ¹/₂ N. 12 miles. — Gravel and sand. — No vegetation.
- RS. ¹/₈ 94. Fornæs light-house W. ¹/₂ S. 15 miles. — 20,5 meters (?). — No vegetation.
- RR. ¹/₈ 94. Fornæs light-house W. ¹/₂ S. 7 miles. — 17 meters (?). — No vegetation.
- ZO. ¹⁰/₇ 05. Lat. N. 56°28'15'', Long. E. 11°23'1¹/₂'. — 15 meters. — No vegetation.
- EO. ¹¹/₇ 92. The light-house S. by E. 9,1 miles. — 26,5 meters. — Clay-mud with shells. — No vegetation, on *Modiola* some few *Lithothamnium* and *Antithamnion plumula*.
- HS. ⁹/₅ 93. Briseis Grund. — 7,5 to 13 meters. — Stones. — *Fucus serratus*, *Furcellaria*, (*Halidrys*, *Laminaria digitata*).
- RP. ²¹/₇ 94. Near Briseis Grund, Lat. N. 56°18,5', Long. E. 11°17,7'. — 20,5 meters. — Stones (gravel?). — No vegetation.
- OS. ¹⁸/₄ 94. Hastens Grund, the buoy S.W. by W. 1⁵/₆ miles. — 13 to 14 meters. — Gravel and stones. — *Fucus serratus*.
- OS¹. ¹⁸/₄ 94. Hastens Grund, the buoy S.W. ¹/₂ S. 1 mile. — 16 meters. — Gravel. — *Fucus serratus*, (*Halidrys*).
- OT. ¹⁸/₄ 94. Hastens Grund, the buoy N.W. by W. ¹/₂ mile. — 9,5 meters. — Stones. — *Laminaria digitata*, *Halidrys*.
- OU. ¹⁸/₄ 94. Schultz's Grund, the buoy S.W. ¹/₂ mile. — Sand with stones. — 9,5 meters. — Abundant vegetation: *Halidrys*, *Laminaria digitata*, (*Fucus serratus*, *Furcellaria*, scarce *Zostera*).
- OV. ¹⁸/₄ 94. The beacon on Sjællands Rev S.E. ¹/₂ E. 1²/₃ miles. — 17 to 19 meters. — Sand. — No vegetation.
- OX. ¹⁹/₄ 94. W. of the beacon on Sjællands Rev. — 9,5 meters. — Stones. — No vegetation.
- OY. ¹⁹/₄ 94. Nearer land. — ca. 4 meters. — Stones. — *Fucus serratus*.
- GG. ²¹/₇ 92. Sjællands Rev, E. side of Mellemrevet. — A good 4 meters. — Stones. — *Fucus serratus*, (*Furcellaria* a. o. *Florideæ*).
- GF. ²¹/₇ 92. Sjællands Rev, in the Snekkeløb. — 8 meters. — Stones. — *Fucus serratus*, (*Florideæ*).
- OQ. ¹⁷/₄ 94. E. of Lille Lysegrund, Hesselø light-house S.E. by S. ¹/₃ S. 8¹/₃ miles. — 20,5 meters. — Sand. — No vegetation.
- OR. ¹⁸/₄ 94. S.W. side of Lille Lysegrund. — 17 to 18 meters. — Brown Sand. — No vegetation.
- EL. ¹¹/₇ 92. N. of Lysegrund, 2²/₃ miles N.W. ¹/₂ W. of the buoy. — 20,5 meters. — Clayey sand. — No vegetation.
- EN. ¹¹/₇ 92. Lysegrund, ¹/₂ mile N. of the 2 meters shallow. — 14 meters. — Stones. — Scarce *Lithoderma*, otherwise no Algæ. — 17 meters: *Polysiphonia violacea*, *Ectocarpus*.
- EM. ¹¹/₇ 92. Lysegrund, ¹/₃ mile N. of the 2 feet shallow. — Ca. 9,5 meters. — Stones. — *Fucus serratus*, (*F. vesiculosus*, *Furcellaria*).
- OP. ¹⁸/₄ 94. Lysegrund, near the 2 meters shallow. — 6 meters. — Stones and gravel. — *Fucus serratus*, *Halidrys*, *Laminaria digitata*.
- EK. ¹¹/₇ 92. W. side of Lysegrund. — 14 meters. — Sand. — No vegetation.
- EJ. ¹¹/₇ 92. Lysegrund, near the triple broom. — 4 to 5,5 meters. — Stones. — *Fucus serratus*, (*Fucus vesiculosus*, *Florideæ*).
- HQ. ⁸/₅ 93. E. side of Lysegrund. — Ca. 9,5 meters. — Sand. — Single clumps of *Fucus serratus* and *F. vesiculosus*.

- HP. $\frac{8}{15}$ 93. S. E. of Lysegrund, $4\frac{1}{2}$ miles N.W. by W. $\frac{1}{6}$ W. of Hesselø light-house. — 25,5 meters. — *Furcellaria*, (*Fucus serratus*).
- RO. $\frac{31}{7}$ 94. W. of Hesselø. — 20,5 meters. — Sandy clay-mud. — *Desmarestia viridis*, otherwise no plants.
- HR. $\frac{8}{15}$ 93. S. of Hesselø. — 19 meters. — Soft bottom. — No vegetation.
- RN. $\frac{31}{7}$ 94. By the Sydostrev by Hesselø. — 21,5 meters. — Gravel. — *Desmarestia viridis*, otherwise no plants.
- B. $\frac{17}{7}$ 90. Hesselø light-house N.W. $\frac{1}{3}$ N. a good 3 miles. — 24,5 to 32 meters. — Soft bottom. — No vegetation.
- A. $\frac{17}{7}$ 90. Hesselø light-house N.W. $\frac{3}{4}$ N. nearly 4 miles. — 28 meters. — Soft bottom. — Loose *Dilsea edulis*, shells of *Cyprina*, *Aporrhais* a. o. with *Lithothamnium* and boring Algæ.
- G. $\frac{17}{7}$ 90. 5 miles N. of the buoy at Grønne Revle. — Ca. 19 to 22,5 meters (?). — No vegetation (only some few *Desmarestia viridis* on *Buccinum* and loose *Dilsea edulis*).
- GH. $\frac{21}{7}$ 92. Lat. N. $56^{\circ}1'40''$, Long. E. $11^{\circ}30'\frac{1}{2}'$. — 19 meters. — Clay-mud. — No vegetation.
- aU. $\frac{6}{8}$ 06. Lumbsaas mill S. 32° W. 2 miles. — 13 meters. — Sand with few stones. — *Furcellaria*, (*Zostera*, *Fuc. serratus*, *Polyides*, *Ectocarpus*). — Another dredging: Larger stones with *Furcellaria*, *Fuc. serratus*, *Laminaria digitata*.
- D. $\frac{17}{7}$ 90. 1 mile N. of the buoy at Grønne Revle. — 11,5 meters. — Stones. — Abundant vegetation: *Fucus serratus*, *Furcellaria*, (*Zostera*, *Phylloph. Brodiaei*, *Laminaria digit.*, *Polyides*, *Ahnfeltia* . .).
- HO. $\frac{8}{15}$ 93. Hesselø light-house W. by N. $\frac{1}{4}$ N. 12 miles. — 22,5 meters. — Clay-mud with stones. — *Lithothamnium*.
- RM. $\frac{31}{7}$ 94. Off Raageleje, Lat. N. $56^{\circ}10'10''$, Long. E. $12^{\circ}5'\frac{1}{2}'$. — 19 meters. — Sand. — No vegetation.
- RL. $\frac{30}{7}$ 94. The buoy at Ostindiefarer Grund S.E. by E. $2\frac{1}{2}$ miles. — 15 meters. — *Florideæ*, particularly *Cystoclonium*, *Furcellaria*, *Phyllophora*, *Chondrus*, (*Laminaria digitata*, *L. saccharina*, *Fucus serratus*).
- EJ. $\frac{11}{7}$ 92. Isefjord, midway between Korshage and Spodsbjerg. — Ca. 4,5 meters. — Sand almost without vegetation.
- EH. $\frac{11}{7}$ 92. Off Lynæs, $\frac{1}{3}$ mile W. of the broom. — 4,5 meters. — Sand with pebbles. — *Chorda Filum*, (*Zostera*, *Rhodomela*, *Polysiphonia elongata* and *nigresc.*).
- NL. $\frac{23}{5}$ 93. $1\frac{5}{6}$ miles W. $\frac{1}{2}$ S. of Lynæs. — 4 meters. — Sand with *Zostera*.
- NM. $\frac{25}{9}$ 93. Roskilde Fjord off Nordskov, Kulhus mill W. $\frac{1}{3}$ N. $1\frac{3}{4}$ miles. — 7,5 meters. — Mud with broad-leaved *Zostera*.
- PQ. $\frac{3}{15}$ 94. E. of Bogenæs in Roskilde Fjord. — 3 meters. — Stones. — *Zostera*, *Mytilus*, *Polysiph. nigresc.*, *Phylloph. Brodiaei*.
- PQ¹. $\frac{3}{15}$ 94. Between Bogenæs and Boserup. — Stones. — *Zostera*, *Potamogeton pectinatus*, *Polysiphonia*, *Ceramium*, *Spirulina versicolor*.

Samsø area. (Sa)

- KK. $\frac{17}{5}$ 93. Klørggrund, S. of Hjelm. — 6,5 to 8,5 meters. — Stones. — *Fucus serratus*, *Hali-drys*, (*Fucus vesic.*).
- KI. $\frac{17}{5}$ 93. Hjelm light-house N. $\frac{1}{2}$ W. $2\frac{1}{2}$ miles. — 13 meters. — Stones. — *Lithothamnium norvegicum*, *Corallina offic.*

- KL. ¹⁷/₅ 93. Bjarkes Grund, S.W. of Hjelm. — 5,5 to 7,5 meters. — Stones. — *Halidrys*, *Laminaria digitata*, *Fucus serratus*.
- KM. ¹⁷/₅ 93. Hjelm light-house E. by N. ³/₈ N. a good ³/₂ miles. — 9,5 to 17 meters. — Stones. — *Halidrys*, *Fucus serratus*, (*Laminaria* ...).
- PJ. ²¹/₄ 94. Ebeltoft Vig, Ellemands Bjerg S.W. ³/₈ miles. — 13 meters. — Clay-mud with stones. — Scarce *Florideæ*.
- FR. ¹⁶/₇ 92. Near Pikkelfgrund in Ebeltoft Vig. — 5,5 meters. — Soft bottom. — Dead *Zostera*-leaves, loose Algæ.
- FQ. ¹⁶/₇ 92. E. side of Ebeltoft Vig. — 8 meters. — Soft bottom. — Broad-leaved *Zostera* and *Chorda Filum*, (loose Algæ).
- MY. ¹⁸/₉ 93. Sletterhage light-house N.W. by N. ³/₄ miles. — 9,5 to 14 meters. — Sand with stones. — *Halidrys*, (*Laminaria sacch.*, *L. digit.*, *Fuc. serratus*, *Corallina off.*).
- FT. ¹⁶/₇ 92. Klepperne, at the N. end of Samsø, inside the double broom. — 5,5 meters. — *Halidrys*, (*Laminaria digitata*, *Florideæ*, in particular *Cystoclonium*).
- PH. ²¹/₄ 94. Lindholms Dyb W. of Vejro, ¹/₄ mile S. of the double broom. — 20,5 meters. — Mud with stones. — *Lithothamnion norvegicum* and *Cruoria pellita*.
- FS. ¹⁶/₇ 92. Vejro Sund, N. of Bosserne. — 4 to 19 meters, (dredging up the slope). — Stones. — Abundant vegetation: *Fuc. serratus*, (*Fuc. vesic.*, *Lamin. digit.*, *L. sacch.*, *Chorda Filum*, *Halidrys*, *Florideæ*).
- PG. ²¹/₄ 94. The beacon on Hatter Rev E. by S. ³/₄ S. ¹/₃ miles. — 7,5 to 8,5 meters. — Stones. — *Laminaria digitata*, (*Lam. sacch.*, *Florideæ*, *Zostera*).
- OZ. ¹⁹/₄ 94. W. of Griben, Sjællands Odde point in E. ²/₃ S. ¹/₃ miles. — 14 meters. — Sand without vegetation.
- PA. ¹⁹/₄ 94. Near Albatros, on the W. side of Sjællands Odde. — Ca. 7,5 meters. — Stones. — *Furcellaria*, (*Laminaria*, *Fucus serratus*).
- GD. ²¹/₇ 92. ¹/₂ miles N.E. by N. of Sejerø light-house. — 11,5 to 14 meters. — Stones. — *Fucus serratus*, (*Laminaria digit.*, *Florideæ* in particular *Furcellaria*, *Delesseria sanguin.*, *sinuosa*, scarce *Zostera*).
- GE. ²¹/₇ 92. Sejerø light-house S.W. by S. 1 mile. — 7,5 to 9,5 meters. — Stones. — *Halidrys*, *Zostera*, *Fuc. serratus*, *Lamin. digit.*, *Florideæ*, in particular *Furcellaria*).
- PB. ¹⁹/₄ 94. Sejerø Bugt, Sejerø light-house N.W. by W. ²/₃ W. nearly 7 miles. — 14 meters. — Clay-mud without plants.
- PC. ¹⁹/₄ 94. Between Sejerø and Ordrups Næs, the point of Ordrups Næs E.S.E. nearly 2 miles. — 4 meters. — Stones. — *Fucus serratus*, *Laminaria digitata*, *Florideæ*.
- YV. ⁵/₆ 04. The light-buoy at Hatterbarn N. ²/₃ miles. — 15 meters. — Stones. — *Florideæ*, in particular *Furcellaria*, *Delesseria sinuosa*, *sanguin.*, *Polysiph. elongata*, and *Laminaria digit.* and *sacchar.*
- PD. ¹⁹/₄ 94. S. of Sejerø, Lat. N. 55°48', Long. E. 11°5'. — Ca. 13 meters (?). — Sand without vegetation.
- PE. ¹⁹/₄ 94. Refsnæs light-house S. by E. ¹/₂ E. ¹/₄ miles. — 23,5 meters. — Clay-mud, gravel and pebbles. — *Laminaria digitata*, *Desmarestia acul.*
- PF. ²¹/₄ 94. The light-buoy at Refsnæs S.E. by E. a good half mile. — 18 to 20,5 meters. — ? with stones. — Scarce vegetation: *Florideæ*, in particular *Delesseria sinuosa*, and *Desmarestia acul.*

- MP. ¹⁶/₉ 93. Falske Bolsax. — 11,5 to 13 (to 19) meters. — Stones. — *Laminaria sacchar.*, *Florideæ*, (*Laminaria digit.*, *Fucus serratus*).
- DK. ¹²/₅ 92. Bolsaxen, N.E. of the broom. — 13 to 15 meters. — Stones. — *Halidrys*, *Laminaria digit.*, (*Desmar. acul.*, *Florideæ*).
- AH¹. ¹²/₈ 91. Lillegrund by Fyens Hoved, by the northernmost broom. — 9,5 meters. — Stones.
Abundant algal vegetation: *Furcellaria*, *Fuc. serratus*, *Lamin. sacchar.*
- AH. ¹²/₈ 91. Same reef, by the middelmost buoy. — 7,5 meters. — Stones. — *Fucus*, (*Laminaria digitata*, *Furcellaria*).
- BF. ²¹/₈ 91. Off Sletterhage, ca. ¹/₂ mile. — 14 meters. — Stones. — *Lithothamnion norvegicum*, (*Corallina offic.*, *Cruoria*, *Brongniartella*).
- BE. ²¹/₈ 91. Off Sletterhage, ca. ²/₃ mile. — 10 meters. — Stones. — *Halidrys*, (*Corallina off.*, *Lithothamnion spp.*, *Chorda Filum*).
- FU. ¹⁸/₇ 92. S. side of Begtrup Vig. — 5,5 meters. — Dead *Zostera*-leaves, living *Zostera*, *Chorda Filum*.
- KN. ¹⁷/₅ 93. Sletterhage light-house S.E. ³/₄ S. 5 miles. — 15 meters. — Sandy clay-mud with small pebbles. — No vegetation.
- AR. ¹⁸/₈ 91. S.W. of Skødshoved, nearly 1 mile. — 4 meters. — Sand. — *Fucus serratus* and *vesiculosus*, (*Halidrys*, *Zostera*).
- PP. ²³/₄ 94. Aarhus Bugt, Ryes Flak. — 4,5 meters. — Small pebbles and gravel. — Spots of *Zostera*, *Fucus vesiculosus*, *Fuc. serratus*, *Halidrys*.
- AP. ¹⁸/₈ 91. W.N.W. of Skødshoved, ²/₃ mile of land. — 17 meters. — Clay-mud without veg.
- PM. ²³/₄ 94. Kalø Vig, Skødshoved S. by E. 1 mile. — 5,5 to 11,5 meters. — No vegetation.
- AQ. ¹⁸/₈ 91. Off the entrance to Knebelvig. — 9,5 meters. — Mud. — *Zostera* in spots.
- PN. ²³/₄ 94. Kalø Vig, Skødshoved point S.W. ²/₃ miles. — 5,5 to 11,5 miles (?) — *Zostera*.
- PO. ²³/₄ 94. Kalø Vig, by Kalø. — 9,5 meters. — Mud without vegetation.
- PL. ²³/₄ 94. E. side of Wulffs Flak. — 9,5 to 13 meters. — Clayey sand. — *Fucus serr.*, *Desmarestia acul.*, *Lithothamnion glaciale*, *Corallina off.* a. o. *Florideæ*.
- FV. ¹⁸/₇ 92. E. side of Hesbjerg Grund. — 6,5 meters. — Sand with small pebbles. — *Zostera*, (*Fucus vesic.*, *Halidrys*, *Furcellaria*).
- PK. ²¹/₄ 94. E. side of Norsminde Flak, the broom in S. ¹/₂ mile. — 5,5 meters and some more. — Sand with stones. — *Zostera* with *Chelopteris* a. o., *Rhodomela*, *Fucus vesic.* and *serr.*, (*Halidrys*, *Corallina off.*).
- AS. ¹⁸/₈ 91. W. side of Meilgrund. — 4 to 5,5 meters. — *Zostera* with *Fuc. serratus*, (*Halidrys*, *Ahnfeltia*).
- BD. ²¹/₈ 91. Tunø light-house S. ³/₈ E. 3 miles. — 15 meters. — Sandy clay-mud. — Scarce vegetation, mostly *Polysiphonia elongata forma*.
- MX. ¹⁸/₉ 93. N. side of Tunø Rev. — 7,5 to 11,5 meters. — Sand. — *Zostera*.
- FX. ¹⁸/₇ 92. Off Dyngby Hage, Tunø light-house E.S.E. ⁵/₂ miles. — 6 meters. — Sand. — *Florideæ*, in particular *Furcellaria*, (*Zostera*, loose *Halidrys*).
- MV. ¹⁸/₉ 93. Kirkegrund S.W. of Tunø. — 7,5 to 9,5 meters. — *Zostera* with scarce *Florideæ*, mostly *Furcellaria*.
- BC. ²¹/₈ 91. Abreast of Hov Røn, the broom N.E. ¹/₂ E. ⁴/₅ mile. — 5,5 meters. — Sand and mud with stones. — Dense *Zostera*-vegetation (with *Fuc. vesic.* and *Furcellaria*).
- MU. ¹⁸/₉ 93. Abreast of Søby Rev, Kolse Nak point S.W. by W. ¹/₆ W. ³/₂ miles. — 6,5 to 7,5 meters. — Dense broad-leaved *Zostera*.

- BB. ²¹/₈ 91. By the buoy at Søgrund. — 3 to 4 meters. — Sandy mud with single stones. — Dense broad-leaved *Zostera*, (*Fucus vesiculosus*).
- AT. ¹⁹/₈ 91. Svanegrund, ¹/₂ mile E.S.E. of the broom at its S.E. side. — 4,5 meters. — Gravel (and sand). — *Fucus serratus*, (*Furcellaria*, *Halidrys*).
- BA. ²¹/₈ 91. Skomagergrund, near the double broom. — 8,5 meters. — Soft bottom. — Dense broad-leaved *Zostera*-vegetation.
- MT. ¹⁶/₉ 93. Horsens Fjord, by the broom W. of Alderø. — 4 to 11,5 meters. — Broad-leaved *Zostera* with *Laminaria saccharina* and *Chorda Filum*.
- AZ. ²⁰/₈ 91. S. side of Søndergrund S. of Hjarnø. — 9,5 to 11,5 meters. — Mud. — Pure *Zostera*-vegetation.
- aV. ⁷/₈ 06. Vestborg light-house E. by S. ⁵/₂ miles. — 8,5 to 9,5 meters. — Sand. — 1) Broad-leaved *Zostera*, *Halidrys*, *Lamin. sacchar.*, *Fucus vesic.* — 2) *Zostera* and dead *Zostera*-leaves, with many loose Algæ, in particular *Ahnfeltia*.
- AO. ¹⁵/₈ 91. ¹/₂ miles S.E. by E. of the S. point of Endelave. — 7,5 meters. — *Zostera* (*Fucus serratus*).
- MR. ¹⁶/₉ 93. Æbelø light-house W. by S. ¹/₂ S. nearly 8 miles. — Ca. 26 meters. — Soft bottom. — No vegetation.
- MQ. ¹⁶/₉ 93. S. of Paludans Flak, Vestborg light-house N. ¹/₂ E. 4 miles. — 11,5 meters. — Sand with stones. — *Fucus serratus*, *Furcellaria*, (*Laminaria digit.*, *Corallina off.*, *Halidrys*, scarce *Zostera*).
- aX. ⁸/₈ 06. At the south side of Endelave. — 4,5 meters. — Sand. — *Zostera*, in spots, with single *Fucus vesic.* and *F. serratus*; numerous loose Algæ between the *Zostera*, on the sand bottom.
- MS. ¹⁰/₉ 93. S. of Kløphagen, Æbelø light-house S.S.W. ¹/₆ W. ⁵/₃ miles. — 15 meters. — Sandy mud with stones. — *Florideæ*, mostly *Polys. nigresc.*, and *Desmarestia acul.*, *Chorda Filum*.
- AY. ²⁰/₈ 91. By the broom at Ashoved. — 9,5 to 11,5 meters. — Sand with stones. — *Zostera*, *Fucus vesic.*, *F. serrat.*, *Furcellaria*.
- FY. ¹⁹/₇ 92. 1 mile N.E. by E. of the point of Bjørnsknude. — 5,5 meters. — Sand with stones. — *Fucus vesiculosus*, (*F. serratus*, *Lamin. digit.*, *Zostera*, *Halidrys*).
- OA. ²⁰/₃ 94. E. of the buoy N. of Æbelø. — 7,5 meters. — *Zostera*, (*Fucus vesicul.*).
- AJ¹. ¹²/₈ 91. By the N. side of Æbelø. — 4 meters. — Stones. — *Fucus serrat.*, *Furcellaria*, *Ahnfeltia*, *Lamin. digit.*
- GB. ²⁰/₇ 92. Æbelø light-house W. ³/₅ miles. — 17 to 18 meters. — Soft bottom. — No vegetation.
- DJ. ¹¹/₅ 95. E. of Æbelø. — 7,5 meters. — Sand with stones. — *Fuc. serratus*, *Furcellaria*, (*Fuc. vesicul.*).
- GC. ²⁰/₇ 92. Æbelø light-house W. by N. ¹/₃ N. ⁶/₄ miles. — 13 meters. — Sand with stones. — *Desmar. aculeata*, (*Florideæ*, dead leaves of *Zostera*).
- NZ. ²⁰/₃ 94. Off Tørresø, Fyns Hoved E. ¹/₆ S. ⁵/₄ miles. — 4,5 meters. — *Fucus serratus*, *F. vesic.*, *Furcellaria*.
- aY. ⁸/₈ 06. Fyns Hoved E. ³/₄ N. ⁴/₄ miles. — 8,5 to 9,5 meters. — Sand with stones. — *Zostera*, *Fucus vesicul.*, *F. serratus*.
- aZ. ⁸/₈ 06. Fyns Hoved E. ³/₄ N. ⁵/₂ miles. — 4 to 5,5 meters. — Sand with stones. — *Fucus vesic.* and *serratus*, (*Zostera* with loose Algæ).
- NY. ²⁰/₃ 94. Off the entrance to Odense Fjord. — 6,5 meters. — *Fucus serratus* and *vesicul.* (*Florideæ*, in particular *Furcellaria*, and *Zostera*).

Little Belt. (Lb)

- AX. ²⁰/₈ 91. Near the double broom at Bjørnsknude. — 9,5 meters. — Clayey sand. — *Zostera*, (*Fuc. serratus*, *Furcellaria*).
- GA. ²⁰/₇ 92. W.N.W. of Æbelø, $2\frac{1}{3}$ miles. — 18 meters. — Clay-mud. — No vegetation.
- AU. ¹⁹/₈ 91. Vejle Fjord, off Barritskov, 1 mile off land. — 17 meters. — No vegetation.
- AV. ¹⁹/₈ 91. Vejle Fjord, off Rosenvold. — 19 meters. — Mud. — No vegetation.
- FZ. ²⁰/₇ 92. Near the triple broom at Kasser Odde. — 6,5 meters. — Sand with stones. — *Fucus vesicul.* and *serratus*, *Halidrys*, *Furcellaria*, *Laminaria digit.*
- AJ. ¹⁴/₈ 91. Trelde Næs N.W. by W. 4 miles. — 13 meters. — Sandy mud. — No vegetation.
- AK. ¹⁴/₈ 91. Stavrhoved W. by S. 1 mile. — 17 meters. — Soft bottom. — No vegetation.
- AL. ¹⁴/₈ 91. W. side of Barring Vig. — 7,5 meters. — Sand (?). — *Furcellaria*, *Zostera*.
- DJ. ¹¹/₆ 92. Trelde Næs N.N.W. 3 miles. — 13 meters. — Mud with dead *Zostera*-leaves. — Few *Florideæ*.
- OB. ²⁰/₈ 94. Off Stavrhoved, $\frac{1}{3}$ mile off land. — 9,5 to 11,5 meters. — Stones. — *Laminaria saccharina* a. o.
- AM. ¹⁴/₈ 91. Sand bank N.E. of Fredericia. — 5,5 to 6,5 meters. — Bare sand.
- AN. ¹⁴/₈ 91. Off the N. end of the wall at Fredericia. — 4 to 5,5 meters. — Stones. — *Fucus vesiculosus*, (*Fuc. serrat.*, *Chorda Fil.*, *Zostera*).
- XQ. ¹²/₇ 00. Lyngsodde S. by W. $\frac{3}{4}$ W. 1 mile. — Ca. 19 meters. — Stones. — *Delesseria sanguinea*, *Phylloph. membranifolia*.
- NX. ²⁰/₈ 94. E.N.E. of Middelfart. — 15 meters. — Clay with stones. — *Laminaria digit.*, *sacchar.*, (*Florideæ*, in particular *Phylloph. membranif.* and *Deless. sinuosa*).
- XP. ¹⁰/₇ 00. Nearly the same place. — Ca. 19 meters. — Stones. — *Laminaria sacch.*, *Deless. sangv.*, *Desmar. viridis*, *Phylloph. membranif.*
- NV. ¹⁹/₈ 94. Between Middelfart and Kongebroen. — 15 to 19 meters. — Stones, and clay with pebbles. — *Laminaria digit.* and *sacchar.*, *Desmarestia acul.*
- EG. ²⁶/₆ 92. By the N.E. side of Fænø Kalv. — Stones. — *Laminariæ* and *Florideæ*.
- OC. ²³/₈ 94. S. of Fænø Kalv. — 14 meters. — Soft bottom. — No vegetation.
- EF. ¹⁸/₆ 92. Fænø Sund, S.E. of Hindsgavl. — Below the *Zostera*-zone stones with *Florideæ* and *Laminariæ*.
- EF¹. ²¹/₆ 92. S. of Hindsgavl. — 9,5 to 11,5 meters. — Stones. — *Laminariæ* and *Florideæ*.
- ED. ¹⁰/₆ 92. S. end of Fænø Sund. — 13 meters. — *Desmarestia acul.*, *Ectocarp. silicul.*, *Laminariæ*, *Florideæ*.
- EE. ¹¹/₆ 92. Between Midskov and Fænø.
- 1) and 2). In the middle of the Belt. — 54,5 to 56 meters. — Stones. — No attached Algæ, but loose fresh *Florideæ*.
 - 3) More westerly. — 34 meters. — Stones. — Fresh Algæ, uncertain whether attached.
 - 4) More westerly. — 13 meters. — Stones. — *Laminariæ*, *Florideæ*, *Desmarestia acul.*
 - 5) E. of 1). — 28 to 36 meters. — Clayey sand with dead shells.
 - 6 and 7). More easterly. — 24,5 and 13 meters. — Sand with stones. — *Desmarestia aculeata*.
 - 8) More easterly. — 11,5 meters. — *Zostera*, (*Florideæ*).
- EC. ¹⁰/₆ 92. S. of Fænø. — Ca. 5,5 meters. — *Zostera* with single *Fucus vesiculosus* and *Laminaria digitata*.

- OD. ²³/₃ 94. S. of the broom at Stenderup Hage. — 17 meters. — Gravel. — Scarce vegetation (*Phylloph. Brodiaei*, *Furcellaria*).
- DH. ¹¹/₅ 92. Near Flækøjet, the broom at Stenderup Hage N.N.E. 1 mile. — 11,5 to 15 meters. — Stones (?). — Scarce Algæ (*Desmarestia aculeata*, *Florideæ*).
- OE. ²³/₃ 94. At the N. side of Brandsø. — 8,5 meters. — *Zostera*, (*Furcellaria*).
- DG. ¹¹/₅ 92. Off Ivernæs. — 5,5 meters. — Sand with stones. — *Zostera*, (*Fucus vesic.*, *Florideæ*).
- OF. ²³/₃ 94. Fyrrenden, Baagø church E. by N. ⁵/₈ N. ¹/₄ miles. — 13 meters. — Mud with dead *Zostera*-leaves, scarce *Florideæ*.
- DF. ¹¹/₅ 92. Remmen, E. of Baagø. — 5,5 meters. — Sand (?) with a few stones. — *Zostera*, (*Fucus vesic.*).
- DE. ¹⁰/₅ 92. By the broom at Thorø. — 5,5 meters. — Sand. — *Zostera*, (*Ceramium Rosenvingii*, *Rhodomela*).
- DD. ¹⁰/₅ 92. N. side of Thorø Banke. — 7,5 meters. — Sand. — *Fucus vesic.*, *Zostera*.
- DC. ¹⁰/₅ 92. Aakrog Bugt, off Brunshus. — 5,5 meters. — Sand (?) with stones. — *Fucus vesicul.*, (*F. serratus*, *Furcellaria*).
- DB. ¹⁰/₅ 92. Lillegrund, W. of Helnæs, near the buoy. — 7,5 meters. — Stones. — *Furcellaria*, (*Fuc. serratus* . . .).
- CD. ²¹/₉ 91. Helnæs Hoved Flak. — 4 meters. — Sand with stones. — *Zostera*, (*Fuc. vesiculosus*).
- CE. ²¹/₉ 91. S. of Helnæs Hoved Flak. — 26,5 meters. — Mud. — No vegetation.
- DA. ¹⁰/₅ 92. Off Bøjgden. — 5,5 meters. — Stones. — *Fucus vesiculosus* and *serratus*.
- CF. ²²/₉ 91. Near the broom W. of Lyø. — 15 meters and some less. — *Florideæ*, (scarce *Zostera*).
- DY. ¹⁴/₅ 92. W. side of Skjoldnæs, Ærø. — 7,5 to 9,5 meters. — Bare sand with spots of *Zostera* (rather small and narrow-leaved).
- LG. ⁴/₇ 93. Off Vidsø, Ærø, ¹/₄ mile of land. — 8 to 10,5 meters. — Sand with a few stones. — *Zostera*, (*Fucus vesiculosus*).
- DX. ¹⁴/₅ 92. Vodrups Flak. — 13 meters. — Sand with stones. — *Florideæ*, in particular *Furcellaria*, *Deless. sinuosa*, (*Fucus serratus*, *Laminaria digit.*).
- LF. ⁴/₇ 93. Vodrups Flak. — 9,5 meters. — Sand. — *Zostera*, *Fucus serratus*, (*Furcellaria*).

The South Fyen Waters (Sydfyenske Øgaard). (Sf)

- CC. ²¹/₉ 91. S. side of Hornenæs. — 7,5 meters. — Sand with stones. — *Zostera*, *Furcellaria*, *Fucus vesiculosus* and *serratus*.
- CZ. ¹⁰/₅ 92. E. of CC. — 9,5 to 15 meters. — Soft bottom. — Few Algæ (*Phyllophora Brodiaei*).
- CB. ²¹/₉ 91. Near the N. side of Lyø Rev. — Ca. 21 meters (?). — Mud. — No vegetation.
- CX. ¹⁰/₅ 92. Between the N. end of Lyø and Knollen. — 19 meters. — Mud. — No vegetation.
- CY. ¹⁰/₅ 92. Near CX. but nearer to Lyø. — 20 meters. — Mud with dead leaves of *Zostera*. — No vegetation.
- CA. ²¹/₉ 91. Faaborg Fjord, W. of the broom at Højen. — Dense vegetation of broad-leaved *Zostera*.
- CG. ²²/₉ 91. S. end of Skrams Flak. — 6,5 meters. — Sand with stones. — *Zostera* with *Fucus serratus* and *vesiculosus*, (*Polys. nigrescens*, *Furcellaria*).
- BZ. ¹⁹/₉ 91. W. of Svelmø. — 15 meters. — Mud, dead *Zostera*-leaves. — No vegetation.
- CU. ⁹/₅ 92. Near the buoy at Flæskholms Flak, N. of Drejø. — 5,5 meters. — *Zostera*.
- CV. ⁹/₅ 92. Billes Grunde, N. of Ærø, the most eastern bank. — 5,5 meters. — Sand with stones. — *Fucus vesic.* and *serratus*, *Florideæ*: *Phyllophora Brodiaei*, *Ceramium Rosenvingii*.

- UX. ²⁵/₁₅ 95. Skjoldnæs light-house S. ³/₄ W. ³/₄ mile. — 9,5 meters. — First sand with *Zostera*, farther out stones with *Laminaria digit.*, *Furcellaria* a. o. *Florideæ*.
- UV. ²⁵/₁₅ 95. Skjoldnæs light-house N.W. ²/₃ W. nearly 5 miles. — 13 meters. — Stones. — *Florideæ*: *Furcellaria*, *Deless. sanguinea* . . ., (*Fucus serratus*).
- DZ. ¹⁴/₅ 92. Egholms Flak, near the buoy at the N. end of Mørke Dyb. — 5,5 meters. — *Zostera*.
- V. ¹⁸/₉ 90. At the W. side of Birkholm. — 4 to 7,5 meters. — *Zostera* with *Fucus vesic.*, *F. serratus*, *Chorda Filum*.
- U. ¹⁸/₉ 90. Same place, nearer to land. — 1 to 2 meters. — *Fucus vesic.*, *Chorda Filum*.
- CT. ⁹/₁₅ 92. The bank W. of Knudedyb W. of Taasinge. — 2 meters. — Stones. — *Fucus vesicul.* and *serratus*. Outside the stones: *Zostera*.
- BY. ¹⁸/₉ 91. Svendborgsund, W. of the pier at Taasinge. — 7,5 meters. — Stones. — *Florideæ*, (*Laminaria sacchar.*).
- BX. ¹⁷/₉ 91. E. of Svendborg, near Taasinge. — 5,5 meters. — Sandy mud, dead *Zostera*-leaves, with scarce *Florideæ*.
- EB. ¹⁵/₅ 92. Near the broom at Stenodde, E. side of Taasinge. — 7,5 meters. — Mud. — *Zostera*.
- EA. ¹⁵/₅ 92. Near the buoy on Middelgrund at the N. end of the Rudkøbing channel. — 5,5 meters. — *Zostera*.

Great Belt. (Sb)

- MO. ¹⁶/₉ 93. Refsnæs light-house N.W. ¹/₃ W. 3 miles. — 19 meters. — Clay-mud with stones. — No vegetation.
- DL. ¹²/₅ 92. S. side of Refsnæs, ¹¹/₂ miles from the light-house. — 6,5 to 7,5 meters. — Bare sand with patches of *Fucus serratus*.
- MN. ¹⁶/₉ 93. The broom at Asnæs S.W. ³/₅ W. a good 3 miles. — 10,5 to 11,5 meters. — Fine sand with stones. — *Zostera*, *Fuc. serratus*, *Laminaria digit.*
- GT. ⁹/₁₁ 92. ¹/₃ mile N. of the broom at Asnæs. — 7,5 meters and probably more. — Stones. — *Florideæ*, in particular *Furcellaria*, (*Deless. sangv.*, *Del. sinuosa*).
- DM. ¹²/₅ 92. Asnæs Rev, inside the broom. — 6,5 meters. — Shells. — Scarce Algæ (*Desmar. aculeata*, *Chorda tomentosa*).
- GU. ⁹/₁₁ 92. The broom at Asnæs N.W. ³/₄ N. 2 miles. — 19 meters. — Stones. — *Laminaria sacch.*, *Desmar. acul.*, *Deless. sangv.*
- GS. ⁹/₁₁ 92. N. side of Lysegrunde S. of Asnæs. — 9 meters (?). — Sand with stones. — *Zostera*, *Fucus serratus*.
- LK. ⁶/₇ 93. Elefantgrund. — 6,5 to 11,5 meters. — Stones. — *Fucus serratus*, *Laminaria digitata*, *Florideæ*, in particular *Furcellaria*.
- AG. ¹²/₈ 91. By the broom at Klæpen W. of Romsø. — 4 meters. — Sand with vegetation in spots of *Furcellaria*, (*Fuc. vesicul.*, *F. serratus*).
- LM. ⁶/₈ 93. By the S. side of Romsø. — 4 to 5,5 meters. — Sand with stones. — *Fucus vesic.*, *F. serratus*, *Halidrys*, (*Lamin. digit.*, *Furcellaria*).
- GV. ⁹/₁₁ 92. By the buoy S.E. of Romsø. — Stones. — *Furcellaria*, (*Halidrys*, *Laminaria sacch.*, *Fuc. vesic.*).
- LN. ⁶/₈ 93. Off the E. side of Stavreshoved. — 5,5 meters. — Stones. — *Fucus vesicul.*, *F. serrat.*, *Halidrys*, *Lamin. digit.* — Also sand with *Zostera*.
- LP. ¹⁷/₈ 93. Off the S.E. side of Stavreshoved. — 2 to 4 meters. — Stones. — *Fucus vesicul.*, (*F. serratus*).

- AF. $^{12}/_8$ 91. Mølleggrund S. of Stavreshoved. — 8 meters. — Sandy mud with dead *Zostera*-leaves. — *Furcellaria*, *Phylloph. Brodiaei*, *Polys. nigresc.*
- LL. $^{2}/_8$ 93. Rønne off Broløkke by Kerteminde. — 4 to 5,5 meters. — Stones. — *Fucus vesicul.*, (*Halidrys*, *Furcellaria*).
- AE. $^{10}/_8$ 91. Off the slope at Lundsgaard. — 7,5 to 9,5 meters. — Clayey sand. — *Zostera*, (*Furcellaria*).
- LO. $^{14}/_8$ 91. Off the valley S. of Lundsgaard. — Ca. 5,5 meters. — Sand with stones. — *Fucus vesicul.*, (*Halidrys*, *Furcellaria*, *Spermatochneus*).
- AD. $^{10}/_8$ 91. Off Risingehoved, ca. $^{3}/_4$ mile off land. — 13 meters. — Clay-mud with dead shells. — Very sparse vegetation on tubes of Annelids a. o.
- MM. $^{15}/_9$ 93. The buoy at Elefantgrund N. by W. $^{3}/_8$ W. 3 miles. — 19 to 20,5 meters. — Soft bottom. — No vegetation.
- GR. $^{9}/_{11}$ 92. Musholm Havn. — 4 meters. — *Zostera*.
- GQ. $^{9}/_{11}$ 92. W. side of Slettings Grund. — 7 meters. — *Zostera*, (*Fucus vesic.*, *F. serratus*).
- NU. $^{25}/_1$ 94. Off the Strandskov by Bogense, $^{1}/_2$ mile of land. — 11,5 meters. — Sand (?) with a few stones. — *Furcellaria*.
- AA. $^{9}/_8$ 91. Sprogø light-house S.E. $^{51}/_6$ miles. — Ca. 26,5 meters. — Clay-mud. — Nearly no vegetation (*Brongniartella*, *Polys. nigrescens*, *Ectocarpus*).
- Z. $^{5}/_8$ 91. Off Skagbo Huse, Sprogø light-house S.E. by E. $^{1}/_8$ E. 5 miles. — 19 meters. — Sandy mud. — Scarce veg.: *Desmar. acul.*, *Polys. nigr.*
- GX. $^{10}/_{11}$ 92. Sprogø light-house S.E. 3 miles. — More than 21 meters. — Clay-mud. — No veg.
- AB. $^{9}/_8$ 91. Off the S. end of Teglgårdsskov by Nyborg, $^{1}/_2$ mile of land. — 7,5 meters. — Sand with stones. — *Fucus vesicul.*, *F. serr.*, *Zostera*, scarce *Florideæ*.
- AC. $^{10}/_8$ 91. Knudshoved light-house S.W. $^{1}/_2$ S. $^{3}/_4$ mile. — 17 meters. — ? with small pebbles. — Scarce veg. of *Florideæ* (*Polys. nigresc.* and *Brongniartella*) and *Desmarestia acul.*
- GY. $^{10}/_{11}$ 92. W. side of Gjelleggrund S. of Sprogø. — 5,5 meters. — Sand with stones. — *Zostera*, (*Fuc. serratus*).
- NO. $^{22}/_1$ 94. E. of Gjelleggrund, Sprogø light-house N.W. by N. $^{1}/_4$ N. $^{12}/_5$ miles. — 13 meters. — Sand (?) with stones. — *Florideæ* and *Chaetomorpha Melagonium*, (*Zostera*).
- GP. $^{9}/_{11}$ 92. Near the light-buoy at Halskov Rev. — 9,5 to 11,5 meters. — Stones. — *Laminaria digitata*, *Delesseria* three species.
- NR. $^{23}/_1$ 94. Immediately N.W. of the entrance to Korsør harbour, between the double broom and the buoy. — Stones. — *Fucus vesiculosus*.
- NP. $^{22}/_1$ 94. $^{2}/_3$ mile W. $^{1}/_2$ S. of the broom at Badstue Rev. — 9,5 meters. — Sand with stones and *Mytilus*. — *Polysiph. elong.* a. o.
- NQ. $^{23}/_1$ 94. Badstue Rev. — 4 to 5,5 meters. — Sand with stones. — *Zostera*, *Mytilus* with a few *Florideæ*, in particular *Rhodomela*.
- NN. $^{22}/_1$ 94. Sprogø light-house N.E. $^{3}/_4$ E. $^{31}/_8$ miles. — 19 meters. — *Florideæ* (*Delesseria sangu.*, *D. sinuosa*, *Rhodomela*).
- NT. $^{25}/_1$ 94. Knudshoved light-house W. by N. $^{6}/_7$ mile. — 19 meters. — Clay-mud or sand. — No vegetation.
- NS. $^{24}/_1$ 94. Between Slipshavn and Knudshoved, $^{2}/_5$ mile of land. — 5,5 meters. — Sand with stones. — *Fucus vesicul.*, *F. serrat.*, *Florideæ*, *Zostera*.
- BS. $^{16}/_9$ 91. W. side of Palegrund. — 7,5 meters. — Mud. — *Zostera*, (*Furcellaria*).

- LJ. ⁵/₇ 93. E. of Palegrund. — 16 meters. — Soft bottom with dead *Zostera*-leaves and some loose *Florideæ*.
- XS. ²⁷/₁₀ 00. By Kløverhage, Knudshoved light-house N.E. ²/₃ N. ²/₃ miles, and a little more north. — 5,5 to 7,5 meters. — Mostly *Zostera*, here and there stones with *Furcellaria*, *Phylloph. Brod.*, *Polys. nigresc.*
- BT. ¹⁵/₉ 91. S. of Kløverhage. — 7,5 meters. — Sandy mud. — Dense *Zostera*-vegetation.
- Y. ¹⁹/₉ 90. By the broom at Stokkebæk Flak. — 4,5 meters. — Sand with stones. — *Fucus vesicul.*, *F. serratus*. — ¹/₄ mile S. of the broom. — 7,5 meters. — *Zostera*.
- BU. ¹⁵/₉ 91. Off Lundeberg. — 5,5 meters. — Mud. — Dense broad-leaved *Zostera*-vegetation.
- CJ. ²³/₉ 91. ¹/₃ mile S.S.W. of the entrance to the Stoense channel. — 5,5 meters. — *Zostera*.
- BV. ¹⁵/₉ 91. Off the S. side of Elsehoved. — 6 meters. — Dense, pure *Zostera*-vegetation.
- UU. ²⁴/₅ 95. Snøde Rev. — 4 to 4,5 meters. — Dense *Zostera*-vegetation.
- X. ¹⁹/₉ 90. 2 miles N.E. of the broom at Turø Rev. — 11 meters. — Clay-mud. — Broad-leaved *Zostera*, no Algæ.
- LH. ⁵/₇ 93. S. of Egeløkke Rev, off Bøstrup. — 8,5 to 10,5 meters. — Soft bottom with stones. — *Zostera*, (*Furcellaria*).
- CH. ²³/₉ 91. ¹/₃ miles E.N.E. ¹/₃ E. of the broom at Turø Rev. — 11,5 meters. — Mud with dead *Zostera*-leaves. — No vegetation.
- ba. ¹⁰/₈ 06. Sprogø light-house N.N.W. 4 miles. — 22,5 to 23,5 meters. — Sand. — No vegetation.
- UE. ²⁰/₅ 95. By the buoy at Vresens Puller. — 6,5 to 7,5 meters. — *Zostera* (with stones on which *Fuc. vesic.*, *F. serratus*, *Lamin. digit.*, *Furcellaria* a. o. *Florideæ*).
- UF. ²⁰/₅ 95. N. point of Langeland S.W. by W. ²/₃ W. ²/₁ miles. — 8,5 meters. — Sand and stones. — *Zostera*, *Fucus serratus*, *Florideæ*, (*Laminaria digitata*).
- DN. ¹³/₅ 92. Vengeance Grund. — 11,5 to 12 meters. — Stones. — *Florideæ* with *Laminaria digitata*, *Fucus serratus* and *Halidrys*.
- DO. ¹³/₅ 92. Langelandsøre, W. side of Omø. — 4 to 5,5 meters. — *Zostera*-vegetation and stones with *Fucus vesiculosus*.
- UG. ²⁰/₅ 95. Langelandsbelt, abreast of Østerhuse, the point by Hov N. by W. ¹/₄ W. ²/₁ miles. — 33 meters. — ? with stones. — Some few loose Algæ.
- UH. ²⁰/₅ 95. Tranekær light-house S.W. by W. ⁴/₁ miles. — 19 to 21,5 meters. — Stones. — *Lamin. digit.*, *Delesseria sangvin.*
- T. ¹⁷/₉ 90. ¹/₂ mile N.W. of the buoy at Staalgrunden. — 4 to 5,5 meters. — Sand with stones. — *Zostera* with a few *Fucus vesicul.*, *Chorda Filum* a. o.
- UT. ²²/₅ 95. Tranekær light-house E. by N. ¹/₃ N. ²/₃ miles. — 19 meters. — Coarse sand with stones. — *Delesseria sangvin.* a. o. *Florideæ*, *Laminaria sacch.* and *digit.*
- UK. ²¹/₅ 95. Abreast of Tranekær light-house, ¹/₂ miles. — 12 meters. — Gravel (?) with some stones. — *Desmarestia acul.*, (*Phylloph. Brodiaei*).
- DP. ¹³/₅ 92. The broom at Onsevig S.W. ¹/₂ W. a good 1 mile. — 6,5 meters. — Sand with some stones. — *Zostera* with some *Fucus vesic.*
- UI. ²⁰/₅ 95. The broom at Onsevig S. a good ¹/₂ mile. — 7,5 meters. — *Zostera*, (*Florideæ* in particular *Furcellaria*, *Rhodomela*).
- DQ. ¹³/₅ 92. N.W. of Nakskov Fjord, Taars ferry outer light-house S.E. ¹/₂ E. ²/₄ miles. — 5,5 meters. — Sandy clay-mud. — *Zostera*, (with *Florideæ*; numerous shells).
- US. ²²/₅ 95. Gillebjerg N.W. ¹/₄ W., Taars light-house E. — Ca. 45 meters. — Stones. — Scarce *Delesseria sinuosa* and *sanguinea*.

- US¹. ²²/₅ 95. Gillebjerg N.W. ¹/₂ W., Taars light-house E. — 20 meters. — Stones. — *Laminaria digitata* and *sacch.*, *Deless. sanguinea*.
- DR. ¹⁴/₅ 92. Near the buoy at Albu Triller. — 8,5 meters. — *Zostera*, (with *Florideæ*).
- DS. ¹⁴/₅ 92. The buoy at Albu Triller N.E. by E. ¹/₄ E. 2 miles. — 11,5 meters. — Sand (?). — No vegetation.
- DT. ¹⁴/₅ 92. Off Magleby on Langeland, ²/₅ mile of land. — 7,5 to 9,5 meters. — Sand. — *Zostera*.
- LB. ⁴/₇ 93. Kjelsnor light-house W. nearly 4 miles. — 17 meters. — Mud with stones. — *Florideæ*, mostly *Delesseria sanguin.*, (*Laminaria digitata*).
- UR. ²²/₅ 95. S. of Albuen, Kappel church E. ¹/₄ N., Fakkebjerg light-house W. ¹/₂ N. — 7,5 meters. — ? with stones. — Rather dense *Zostera*-vegetation, (*Mytilus*, various *Florideæ*, some *Fucus serratus*).

Smaaland Sea. (Sm)

- GZ. ¹⁰/₁₁ 92. 1 ¹/₂ miles N. of the N. end of Egholm. — 6,5 meters. — Sand with stones. — *Zostera*, (*Fucus serratus*, *F. vesicul.*).
- HA. ¹⁰/₁₁ 92. Agersø Sund, the broom off the channel to Skelskør Nor S.E. ¹/₄ E. a good 1 mile. — 11,5 meters. — Stones. — *Florideæ*, (*Polysiphonia*, *Delesseria*).
- VB. ²⁷/₅ 95. E. side of Omø Tofte. — 5,5 meters. — Sand with *Mytilus*, among which various Algæ, mostly *Furcellaria* and *Ceram. rubrum*.
- HB. ¹¹/₁₁ 92. S. end of Agersø Sund, Helleholm light-house N.W. by W. ³/₈ W. 3 miles. — 8,5 meters. — Stones and *Mytilus*. — *Rhodomela* and *Polysiph. nigresc.*, (*Zostera*).
- VC. ²⁷/₅ 95. Venegrund, inside the buoy. — 4 to 5,5 meters. — Sand with stones. — *Zostera*, not dense, various Algæ, *Mytilus*.
- HC. ¹¹/₁₁ 92. By the broom at Knudshoved Odde. — 11,5 meters. — *Zostera*. — *Florideæ* (*Polys. nigrescens*).
- CK. ²³/₉ 91. 2 miles S. by E. ³/₄ E. of the buoy at Staalgrund. — 9,5 meters. — Sand (?) with stones. — *Furcellaria*, (*Phyllophora membranif.*, *Ph. Brodiaei*, *Polys. nigresc.*).
- CL. ²³/₉ 91. In the middle of Raagø Sund. — 5,5 meters. — Dense veg. of broad-leaved *Zostera*.
- CM. ²³/₉ 91. By the broom at Kragenæs. — 4,5 meters. — Dense broad-leaved *Zostera*.
- S. ¹⁶/₉ 90. By the W. side of Fejø. — 5,5 meters. — *Zostera*.
- CN. ²³/₉ 91. N.E. of Middelgrund at the E. end of Fejø. — 4,5 meters. — *Zostera*, (*Fuc. serratus*, *Furcellaria*).
- HD. ¹¹/₁₁ 92. Knudskov Rev. — 4,5 meters. — *Fucus vesicul.*, (*Zostera*).
- CQ. ²⁵/₉ 91. 1 ³/₄ miles N.E. by E. ¹/₅ E. of the broom at Kogrund. — 4,5 meters. — Sand with a few stones. — *Zostera*, (*Fucus vesicul.*).
- Q. ¹⁵/₉ 90. N. of Vesterskovsflak. — 7,5 meters. — Sand. — *Zostera*.
- P. ¹⁵/₉ 90. Between Kogrund and Suderø, ¹/₄ mile S.E. by E. of the broom inside of Kogrund. — 3 meters. — Dense *Zostera*-vegetation with scarce *Fucus*.
- CO. ²³/₉ 91. By the broom at Vigsø Skal. — Ca. 6 meters. — *Zostera*.
- CP. ²⁵/₉ 91. By the broom at Guldborg. — 4 meters. — *Zostera*.
- O. ¹⁵/₉ 90. Off Guldborg. — 5,5 meters. — Mud without vegetation.
- N. ¹⁴/₉ 90. Guldborgsund, off Vennerslund. — 1 to 2 feet: *Polysiphonia violacea* f. *aculeata* a. o. scattered. — 2 feet: *Potamogeton pectinatus* and *Zannichellia pedicellata*. — 3 feet: *Spermatocchnus paradoxus*, *Fucus serratus* a. o. — 3 to 4 feet and outwards: *Zostera*.

- CR. ²⁵/₉ 91. By the beacon at the W. end of Stor Strøm. — 4,5 meters. — Broad-leaved *Zostera*.
 HE. ¹¹/₁₁ 92. W. end of Masnedsund, near the beacon. — 4 to 5,5 meters (?). — Sand. — Pure *Zostera*-vegetation.
 KP. ²/₇ 93. S.E. of Masnedø, between Kalvestrøm and Færgestrøm. — Ca. 3 meters. — *Zostera*, with scattered *Fucus vesic.*
 HF. ¹²/₁₁ 92. W. of Farø, about ²/₃ mile of land. — 12 meters. — Mud with stones and dead *Zostera*-leaves. — Very scarce *Florideæ*.
 R. ¹⁶/₉ 90. Off Petersværft, near land. — Ca. 2 meters. — *Zostera*.
 R¹. ¹⁶/₉ 90. Off Sprove, Møen, right opposite Langø. — From 1,3 meters outwards *Zostera*. — In the channel mud without vegetation.
 HJ. ¹²/₁₁ 92. Bredemands Hage by the S. side of Bogø. — 6,5 meters. — *Zostera*, dead and probably also growing, (scarce *Florideæ*).
 KQ. ²/₇ 93. Grønsund, off the N. end of Østerskov. — 4 meters. — Bare sand. — 3,5 meters: *Zostera*.

The Sound. (Su)

- RX. ¹/₈ 94. Outside of Møllegrund off Høganäs. — 15 meters. — Clay-mud with stones. — No vegetation.
 BQ. ¹²/₉ 91. Off Ellekilde. — 5,5 meters. — Stones. — *Fucus vesic.*, *Fuc. serratus*, (*Furcellaria* a. o. *Florideæ*).
 BR. ¹²/₉ 91. Off Odinshøj. — 9,5 to 11,5 meters. — *Zostera*-vegetation.
 CS. ¹/₅ 92. Off Aalsgaarde. — 4 to 5,5 meters. — Stones. — (*Fucus vesiculosus*, *F. serratus*, and *Florideæ*).
 GK. ⁴/₈ 92. Off Hellebæk. — Between first and second shoal. — Stones. — *Fucus serratus*, (*F. vesicul.*, *Furcellaria*).
 ON. ¹⁷/₄ 94. E. side of Lappegrund. — 6,5 to 9,5 meters. — Coarse sand with pebbles. — No vegetation.
 HN. ⁸/₅ 93. Øretvisten, E. side, Kronborg light-house S.W. ³/₅ S. 2 miles. — 17 to 19 meters. — No vegetation.
 HM. ⁸/₅ 93. Øretvisten, Kronborg S.W. ³/₅ S. 1³/₅ miles. — 24,5 to 28 meters. — Clay-mud. — (A stone with a young *Lithothamnion*, one spec. of *Delesseria sanguinea*).
 HL. ⁸/₅ 93. Øretvisten, Kronborg S.W. ¹/₄ S. 1¹/₄ mile. — 41,5 meters. — Soft bottom (?). — No vegetation.
 OK. ¹⁷/₄ 94. Disken, Lat. N. 56°0,3', Long. E. 12°38,5'. — 7,5 meters. — Bare sand.
 OM. ¹⁷/₄ 94. W. side of Disken, Lat. N. 56°0,2', Long. E. 12°38'. — Sand. — No vegetation (*Mytilus*).
 OL. ¹⁷/₄ 94. E. side of Disken, Lat. N. 56°0', Long. E. 12°37,7'. — 14 to 16 meters. — Sand. — No vegetation.
 PX. ²³/₇ 94. Off Tibberup. — 8,5 meters. — Sandy mud with a few small pebbles. — Dense vegetation of *Zostera*, (with *Fucus vesiculosus*, *Rhodomela*, *Polysiph. nigrescens*).
 TD. ¹⁰/₉ 94. Hveens revolving light S. ¹/₂ W. 2¹/₂ miles. — 20,5 meters. — No vegetation (seine).
 OI. ¹⁷/₄ 94. Nivaa Flak, off Nivaa. — 6,5 meters. — *Rhodomela* (seine).
 HK. ⁸/₅ 93. Off the N.W. end of Hveen. — 17 meters. — Clay-mud. — No vegetation. — 9,5 to 21,5 meters: In part clay-mud. — A few Algæ (*Polysiph. nigresc.*, *Ceramium rubrum*, *Delesseria sinuosa*).

- TC. ¹⁰/₉ 94. Hveens revolving light N. ¹/₂ W. ¹/₂ mile. — 17 meters. — Clay-mud (?). — No vegetation (seine).
- PV. ²³/₉ 94. N. end of Lous's Flak, Hveens revolving light E. by N. ¹/₂ N. 3 miles. — 10 meters. — Fine sand. — *Zostera*.
- OH. ¹⁷/₉ 94. Vedbæk W.S.W. ¹/₄ S. 1 mile. — 9,5 to 10,5 meters. — Sandy clay-mud with a few stones. — *Florideæ*, in particular *Furcellaria* and *Rhodomela*, (*Laminaria sacchar.*).
- PY. ²³/₇ 94. E. of Hveen, Haken light-house S. ¹/₂ W. 1 mile. — 40,5 meters. — Clay-mud. — No vegetation.
- PZ. ²³/₇ 94. Near the E. side of Hveen, Haken light-house S. by E. ¹/₄ E. 1 mile. — 10,5 to 19 meters. — Stones, from 12 meters upwards. — *Florideæ*, *Laminaria sacchar.*
- TE. ²⁵/₉ 94. W. of Staffans Flak, Haken light-house N.N.W. ¹/₄ N. a good 1,5 mile. — 22,5 to 30 meters. — Clay-mud with stones. — No plants.
— The channel between Hveen and Landskrona. — 45 meters. — Clay-mud. — No plants.
- TF¹. ²⁵/₉ 94. Staffans Flak. — 12 to 13 meters. — Stones. — *Laminaria sacch.*, *Florideæ*, in particular *Furcellaria*, (*Chorda Filum*).
- TF². ²⁵/₉ 94. Immediately S. of Staffans Flak. — 28 to 32 meters. — Clay-mud and stones. — No plants.
- TF³. ²⁵/₉ 94. S.W. border of Staffans Flak. — 14 to 18 meters. — *Laminaria digitata*, *Florideæ*, *Phymatolithon polymorphum*.
- QA. ²³/₇ 94. By the buoy at Pilhaken, off Landskrona. — 24,5 to 39,5 meters. — No vegetation.
- QB. ²³/₇ 94. S. of the same buoy. — 16 meters. — Coarse sand, almost without vegetation, (a few *Desmarestia viridis* and *Ectocarpus*).
- bM. ¹⁴/₇ 07. S. of Hveen, 1 mile W.S.W. ¹/₄ S. of the whistle buoy at Pilhaken. — 22,5 meters. — Stones. — Abundant vegetation: *Laminaria digitata*, *L. sacchar.*, *Florideæ*, in particular *Delesseria sinuosa* and *sanguinea*.
- RZ. E. of Lous Flak, Lat. N. 55°51,6', Long. E. 12°41,5'. — 13 meters. — Clay-mud. — A few Algæ.
- RY. Lous Flak, Lat. N. 55°51,5', Long. E. 12°38'. — 12 meters. — Sandy clay-mud. — *Cladophora gracilis*.
- bN. ¹⁴/₇ 07. — Off Vedbæk, Lat. N. 55°51', Long. E. 12°36,5'. — 13 meters. — Abundant vegetation of Algæ and *Zostera*; of Algæ mostly *Ectocarpus*, *Furcellaria*, *Polysiphonia elong.* and *nigrescens*, *Rhodomela*.
- RK. ³⁰/₇ 94. Off Eremitagen, ³/₄ mile of land. — 7,5 meters. — Sand and mud. — *Zostera* and *Furcellaria* (probably loose).
- PT. ²¹/₇ 94. By the broom at Taarbæk Rev. — Stones. — Abundant vegetation: *Fucus serratus*, *Furcellaria*, *Polysiph. nigrescens*, *Chorda Filum*, *Zostera*.
- OG. ¹⁷/₄ 94. Taarbæk Rev, nearly 1 mile W. of the broom. — 6 meters. — Sand with stones. — *Florideæ*, in particular *Furcellaria* and *Rhodomela*, *Fuc. serratus*.
- PU. ²¹/₇ 94. The broom at Taarbæk Rev N.W. by W. ¹/₃ W. ²/₁₀ miles. — 12 meters. — No vegetation.
- TB. ¹⁰/₉ 94. The harbour of Skovshoved W.S.W. ¹/₂ mile. — 5,5 meters. — Sand (?) with stones. — *Furcellaria*, *Zostera*, (*Chorda Filum*).
- TA. ¹⁰/₉ 94. Near the harbour of Skovshoved. — 4,5 meters. — Sand. — *Zostera*.
- PS. ²¹/₇ 94. Off Charlottenlund, the broom at Taarbæk Rev N.E. ¹/₂ N. ²/₁₃ miles. — 5,5 meters. — Sand with stones. — Abundant vegetation: *Zostera*, *Ectocarpus*, *Chorda Filum*, *Furcellaria*.

- KO¹. ¹⁸/₁₀ 93. Off the fort of Charlottenlund. — 3 meters. — Stones. — *Chorda Filum*, *Cladophora*.
- KO². ¹⁸/₁₀ 93. A little farther out. — 7 meters. — Stones. — *Fucus serratus*, *Laminaria sacch.*, *Furcellaria*, *Zostera*.
- OG¹. ¹⁰/₄ 94. Between Trekroner and Middelgrund. — Ca. 9,5 meters (?). — *Desmarestia acul.*, *Delesseria sinuosa* and *alata*, *Chaetopteris*...
- RI. ³⁰/₇ 94. S. end of Middelgrund, between the beacon and the triple broom. — 5 meters. — Gravel with stones. — *Chorda Filum*, (scarce *Zostera*).
- QE. ²³/₇ 94. Nordre Røse. — 10,5 meters. — Gravel and stones. — No plants. — 5 to ca. 10 meters: Stones. — *Zostera*, *Chorda Filum*, (*Mytilus*).
- RH. ³⁰/₇ 94. S. end of Knollen. — 9,5 meters. — Stones. — *Laminaria sacchar.*, *Florideæ*, mostly *Polysiphonia violacea*, broad-leaved *Zostera*.
- QC. ²³/₇ 94. E. side of Saltholms Flak, ²/₃ mile E. ⁵/₆ S. of the broom. — 6 meters. — Sand (?) with stones. — Dense vegetation of *Fucus vesiculosus*, *F. serratus*, *Furcellaria* a. o. *Florideæ*, *Chorda Filum*.
- QD. ²³/₇ 94. E. of the N. end of Saltholm, 1 mile S.S.W. ¹/₂ S. of the beacon. — 5,5 meters. — Sand (?) with stones. — Dense vegetation of *Fucus serratus*, *Furcellaria*, *Polysiph. nigrescens*, *Zostera*.
- SA. ²/₈ 94. Flinterenden; ¹/₄ mile S. of the buoy at N. Flint. — 10,5 meters. — Stones and black mud. — Broad-leaved *Zostera*, *Laminaria sacchar.*, (*Dictyosiphon*, *Laminaria digit.*).
- SB. ²/₈ 94. Flinterenden; ³/₈ mile S.W. of Oscargrund light-ship. — 8,5 meters. — Stones. — *Fucus serratus*, (*Florideæ*, *Dictyosiphon foeniculaceus*).
- PR. ²⁴/₅ 94. Off Dragør. — 7,5 to 9,5 meters. — Hard bottom with stones. — *Florideæ*: *Rhodomela*, *Polysiph. nigrescens*, *Furcellaria* and *Zostera*.
- PR¹. ²⁴/₅ 94. About the same place but farther out. — Ca. 7,5 meters. — *Zostera* and the same Algæ as in PR.

Baltic, Western Part. (Bw)

- VA. ²⁵/₅ 95. Vejsnæs Nakke E. ¹/₃ N. — 26,5 meters. — Sand and pebbles. — No vegetation.
- DV. ¹⁴/₅ 92. S. of Marstal, Fakkebjerg light-house S.E. ³/₄ E. nearly 7 miles. — 9,5 to 11,5 meters. — Sand with pebbles. — *Zostera*, *Fucus serratus*, *Furcellaria*.
- LE. ⁴/₇ 93. N. side of Vejsnæs Flak. — 9,5 meters. — Sand. — *Zostera*, (*Fucus serratus*, *Florideæ*).
- UY. ²⁵/₅ 95. Vejsnæs Flak. — 9,5 meters. — Bare sand with a few stones, on which *Fucus vesiculosus* and *F. serratus*, (and some *Florideæ*).
- UY¹. ²⁵/₅ 95. S. side of Vejsnæs Flak. — 18 meters. — Sandy clay-mud. — Loose *Furcellaria*, *Laminaria digitata*.
- UZ. ²⁵/₅ 95. In the channel E. of Vejsnæs Flak. — 34 meters. — Clayey sand with small stones. — No vegetation.
- LD. ⁴/₇ 93. Fakkebjerg light-house E.S.E. ¹/₄ E. ⁶/₃ miles. — 20,5 to 22,5 meters. — Clay-mud without vegetation (*Ophiuræ*).
- DU. ¹⁴/₅ 92. Off Dimesodde S. of Bagnkop, ¹/₃ mile of land. — 11 meters. — Stones. — *Furcellaria*, (*Fucus serratus*, *Laminaria digitata*...).
- LC. ⁴/₇ 93. S. of the buoy at Gulstav. — 11,5 meters. — Stones. — *Florideæ*, mostly *Furcellaria*, *Fucus serratus*, *Halidrys*, *Laminaria digit.*

- UL. ²¹/₅ 95. Femerbelt; Øjet, Markelsdorf Huk S. ⁵/₈ E. 7 miles. — 20 meters. — Gravel with stones. — Abundant vegetation: *Laminaria digitata*, *L. saccharina*, *Florideæ*.
- LA. ³/₇ 93. Kappel church N. by W. ³/₄ W., W. end of Vesterskov N. ¹/₄ W. — 7,5 meters. — Sand with some stones. — *Zostera*, *Florideæ*, (*Fucus vesiculosus*).
- UQ. ²²/₅ 95. Tillitse church N.E., Kappel church N. by W. ¹/₂ W. — 12 meters. — Gravel and stones. — *Mytilus* with *Polysiphonia nigrescens* and a few other *Florideæ*.
- UP. ²²/₅ 95. Off Kramnisse Gab, ¹/₄ miles of land. — 8,5 meters. — Sand with stones. — Some *Zostera*, scarce *Furcellaria* and *Fucus serratus*, (*Mytilus*).
- KZ. ³/₇ 93. Immediately outside Kramnisse Gab. — 7,5 meters. — *Zostera*, *Fucus serratus*, *Furcellaria*.
- KY. ³/₇ 93. Ølstrup church E.N.E. 6 miles. — 12,5 meters. — Gravel and stones, *Mytilus*. — *Florideæ*, in particular *Ceramium* and *Polysiph. nigrescens*, (dead *Zostera*-leaves).
- KX. ³/₇ 93. Olenburg Huk S.W. by W. ³/₄ W. a good 6 miles. — 26,5 meters (?). — Mud. — A few *Florideæ* on stones.
- KV. ³/₇ 93. S. of Nysted, the buoy N.E. by N. ¹/₂ mile. — 5,5 meters. — Sand. — *Zostera* in large patches, *Florideæ*.
- KU. ³/₇ 93. Schönheyders Palle. — 6,5 meters. — Stones. — *Fucus serratus*, *Florideæ*, (*Laminaria digitata*).
- ²¹/₅ 95. — 7 meters. — Small pebbles or coarse gravel, in great measure without vegetation, with however patches of *Fucus serratus* and a few *Florideæ* and some *Zostera*, (*Mytilus*).
- KT. ²/₇ 93. Gjedser Rev, near the inmost broom. — 8,5 meters. — Stones. — *Fucus serratus*, *Florideæ*, in particular *Ceramium Rosenvingii*.
- UO. ²¹/₅ 95. Gjedser Rev, Trindelen. — 5,5 to 7 meters. — Sand, gravel. — No vegetation.
- UN¹. ²¹/₅ 95. Gjedser Rev, Yderknoben. — 5,5 to 9,5 meters. — Sand and coarse gravel without vegetation.
- UN. ²¹/₅ 95. Gjedser Rev, by "Varsko". — 9,5 meters. — Sand without vegetation.
- UM¹. ²¹/₅ 95. Near Gjedser Revs light-ship. — 19 meters. — Sand without vegetation.
- UM. ²¹/₅ 95. Kadetrenden; Gjedser Revs light-ship N.W. ¹/₆ miles. — 24,5 to 25,5 meters. — Small pebbles. — No vegetation, (a few *Hildenbrandtia* a. o.).

Baltic, Part around Møen. (Bm)

- QF. ²³/₇ 94. W. of Lille Grund by Flinterenden, Drogdens light-ship N. by W. ¹/₄ W. nearly 3 miles. — 9,5 meters (?). — Stones. — *Zostera*, *Fucus serratus*, broad, *Ectocarpus*, (*Mytilus*).
- RG. ³⁰/₇ 94. Falsterbo light-house S.S.E. 6 miles. — Sand, stones. — *Fucus serratus*, *Florideæ*, (the Algæ probably in part loose).
- QG. ²⁴/₇ 94. Abreast of Bredgrund, ¹/₂ mile N.E. ¹/₂ E. of the broom at Virago Grund. — 7,5 meters. — Stones. — *Fucus serratus*, *F. vesiculosus*.
- QM. ²⁴/₇ 94. N. of Juels Grund, harbour of Køge W. ⁵/₂ miles. — 6,5 to 7,5 meters. — Sand with stones. — Abundant vegetation of *Fucus vesiculosus*, *Polysiph. nigrescens* a. o. *Florideæ*, *Zostera*.
- QL. ²⁴/₇ 94. S. of Juels Grund. — 11,5 meters. — No vegetation.
- QK. ²⁴/₇ 94. Off Køge Søhuse. — 9,5 meters. — Fine sand. — *Zostera*.
- QN. ²⁴/₇ 94. Off Køge Søhuse, ³/₄ mile of land. — 6,5 meters. — Stones. — *Fucus serratus*, (with *Florideæ*).

- QI. ²⁴/₇ 94. Køge Bugt, 7 miles due N. of Stevns light-house. — 16 meters (scine). — *Florideæ*, *Laminariæ*.
- QO. ²⁴/₇ 94. Køge Sønakke N.W. ¹/₄ W. 1,3 miles. — 4,5 to 5,5 meters. — Stones. — *Fucus vesiculosus*, *Florideæ*.
- QP. ²⁴/₇ 94. Kalkgrund, at the N. end of Stevns Klint. — 3 to 4 meters. — Limestones. — *Fucus vesiculosus* and *F. serratus*, (*Ceram. rubrum*, *Chorda Filum*).
- VF. ²⁸/₅ 95. Off Mandehoved, Stevns. — 4 to 9,5 meters. — Limestones. — Rather abundant vegetation: *Fucus vesiculosus* and *F. serratus*, (*Polys. nigrescens*).
- QJ. ²⁴/₇ 94. 6 miles due W. of Falsterbo light-house. — 16 meters. — Fine sand. — No vegetation.
- QH. ²⁴/₇ 94. Falsterbo light-house N.E. ¹/₂ E. 2¹/₂ miles. — Ca. 7,5 meters. — Sand. — *Zostera*, *Fucus vesiculosus* a. o.
- SC. ²⁴/₈ 94. Falsterbo light-ship S.E. ¹/₂ S. 2¹/₂ miles. — 9,5 meters. — Fine Sand. — No vegetation.
- VE. ²⁸/₅ 95. Stevns light-house N.E. ¹/₂ E. 1¹/₃ miles. — 15 meters. — Gravel, small pebbles. — No vegetation.
- QQ. ²⁴/₇ 94. Off Rødvig. — 6,5 to 7,5 meters. — Stones. — *Fucus vesiculosus*, (*F. serratus*).
- VD. ²⁷/₅ 95. Near the whistle buoy at the entrance to Bøgestrømmen. — 7,5 meters. — Sand with stones. — *Fucus vesiculosus*, *F. serratus*...
- RA. ²⁵/₇ 94. Hollænder Grund. — 5,5 meters. — Stones. — *Fucus vesiculosus*, *Spermatocnusus*.
- RB. ²⁵/₇ 94. Inside Hollænder Grund. — 4,5 meters. — Sand and gravel with stones. — *Fucus vesiculosus*, *Zostera*; the vegetation here and there wanting.
- QR. ²⁵/₇ 94. Gyldenløves Flak. — 7,5 meters. — Gravel with stones. — *Fucus vesiculosus*.
- SD. ²⁴/₈ 94. Stevns light-house N. by W. ¹/₄ W. nearly 13 miles. — 23,5 meters. — Sand. — Loose *Florideæ* in abundance, in particular *Furcellaria*, *Delesseria sanguinea*, *D. alata*, *Rhodomela*, *Polysiphonia nigrescens*.
- QS. ²⁵/₇ 94. The Møen cliff S.S.W. 7 miles. — 20,5 meters. — Gravel and small stones. — *Florideæ*, in particular *Rhodomela*, *Delesseria sanguinea*, *D. alata*, for the most part loose, (many *Mytilus*).
- VG. ²⁸/₅ 95. N. of the Møen cliff, abreast of Hellehavns Nakke, ³/₄ mile of land. — 17 meters. — Gravel and stones. — *Mytilus* with various *Florideæ*.
- RC. ²⁶/₇ 94. Inside "Danneskiold" near the Møen cliff. — 7,5 meters. — Stones. — *Fucus vesiculosus*.
- QZ. ²⁵/₇ 94. Abreast of Møen light-house. — Ca. 7,5 meters. — Stones. — *Fucus vesiculosus*, *F. serratus*, a great many loose *Rhodymenia palmata*.
- QY. ²⁵/₇ 94. S. side of Bjelkes Flak. — 10,5 meters. — Stones. — *Fucus serratus*.
- VH. ²⁸/₅ 95. S. side of Bøchers Grund. — 8,5 to 10,5 meters. — Sand and stones. — *Fucus serratus* and *F. vesiculosus*.
- VI. ²⁸/₅ 95. Off Hjelm, Møen, near land. — 5,5 to 6,5 meters. — Gravel with stones. — *Fucus serratus* and *vesiculosus*, (*Rhodomela*, *Polysiph. nigrescens*).
- HG. ¹²/₁₁ 92. Præstebjergs Rev, N. of the broom. — 7 meters. — Stones. — *Fucus vesiculosus* and *serratus*.
- HH. ¹²/₁₁ 92. The broom at Præstebjergs Rev N.W. by W. a good 2 miles. — 17 meters. — Clay-mud. — No vegetation.
- KR. ²⁴/₇ 93. By Korselitze Grund. — 7,5 meters. — Sand with stones. — *Fucus vesiculosus*, *F. serratus*, *Florideæ*.

- KS. $2\frac{1}{7}$ 93. E. of Falster, off Ulfeslev; Gjedser light-ship S.S.W. $\frac{3}{4}$ W. $11\frac{1}{2}$ miles. — 9,5 to 11,5 meters. — Gravel and stones, *Fucus vesicul.* and *serratus*, *Florideæ*, in particular *Rhodomela* and *Polys. nigrescens*.
- bO. $17\frac{1}{7}$ 07. Lat. N. $54^{\circ}37'$, Long. E. $12^{\circ}25'$ (Mag. O. PAULSEN). — 15 meters (trawl). — *Laminaria sacchar.*, *Desmarestia acul.*, various *Florideæ*.
- QV. $25\frac{1}{7}$ 94. Lat. N. $54^{\circ}43,6'$, Long. E. $12^{\circ}28,5'$. — 17 meters. — Sand. — No vegetation.
- QX. $25\frac{1}{7}$ 94. Lat. N. $54^{\circ}49,7'$, Long. E. $12^{\circ}28,4'$. — 20,5 meters. — Fine sand. — No vegetation.
- QU. $25\frac{1}{7}$ 94. Lat. N. $54^{\circ}46,6'$, Long. E. $12^{\circ}34\frac{2}{3}'$. — 16 meters. — Fine sand. — No vegetation.
- SE. $2\frac{1}{8}$ 94. Lat. N. $55^{\circ}4'$, Long. E. $12^{\circ}47'$. — 28 meters. — Clay-mud without vegetation.
- QT. $25\frac{1}{7}$ 94. Møen light-house W. by N. $10\frac{2}{3}$ miles. — 34 meters. — Clay-mud with fine sand. — No vegetation.
- bP. $18\frac{1}{7}$ 07. E. side of Kriegers Flak, Lat. N. $55^{\circ}3'$, Long. E. $13^{\circ}5'$ (?) (Mag. O. PAULSEN). — Ca. 15 (18?) meters. — *Rhodomela*, *Ceramium strictum*, *Desmarestia viridis* a. o.
- RF. $30\frac{1}{7}$ 94. Lat. N. $55^{\circ}10'$, Long. E. $13^{\circ}15'$. — 37,5 meters. — Sand and clay-mud, a few small stones. — No vegetation.

Baltic, Part around Bornholm. (Bb)

- RE. $30\frac{1}{7}$ 94. Lat. N. $55^{\circ}10'$, Long. E. 14° . — Ca. 40 meters. — No vegetation.
- SF. $3\frac{1}{8}$ 94. Adler Grund, $\frac{1}{2}$ mile S. of the light-ship. — Ca. 10,5 meters. — Sand with stones. — *Furcellaria*, *Ceramium vertebrale*.
- SG. $3\frac{1}{8}$ 94. Adler Grund, $1\frac{3}{4}$ miles S. by E. $\frac{1}{4}$ E. of the light-ship. — Stones. — 10,5 meters. — *Furcellaria*, *Ceramium vertebrale*.
- SC. $7\frac{1}{8}$ 94. Rønne Banke, Lat. N. $54^{\circ}54'$, Long. E. $14^{\circ}33'$. — 24,5 meters. — Hard sand with stones. — Scarce vegetation, in particular *Rhodomela* and *Ectocarpus littoralis*.
- ST. $7\frac{1}{8}$ 94. W. side of Rønne Banke, Lat. N. $54^{\circ}55\frac{3}{4}'$, Long. E. $14^{\circ}33'$. — 18 meters. — Stones. — *Mytilus*; a few *Florideæ* and *Ectocarpus littoralis*.
- SS. $7\frac{1}{8}$ 94. W. side of Rønne Banke, Lat. N. $54^{\circ}58\frac{1}{4}'$, Long. E. $14^{\circ}32\frac{1}{2}'$. — 19 meters. — Stones, gravel. — *Sphacelaria racemosa*.
- SH. $3\frac{1}{8}$ 94. Rønne Banke, Lat. N. $54^{\circ}59\frac{1}{3}'$, Long. E. $14^{\circ}45\frac{1}{3}'$. — Stones. — *Stictyosiphon*, *Ceramium*.
- SR. $7\frac{1}{8}$ 94. Rønne Banke, Lat. N. $55^{\circ}1\frac{3}{4}'$, Long. E. $14^{\circ}41\frac{1}{3}'$. — 15 to 16 meters. — Gravel and stones. — *Florideæ*, in particular *Rhodomela* and *Ectocarpus*.
- YI. $11\frac{1}{7}$ 01. Port of Rønne E. by N. $2\frac{3}{4}$ miles. — 33 meters. — No vegetation.
- YH. $11\frac{1}{7}$ 01. Port of Rønne E.N.E. $1\frac{1}{2}$ miles. — 24,5 meters. — Stones. — Incrusting Algæ (*Hildenbrandtia*, *Lithoderma*), a few arbuscular *Florideæ*.
- RD. $27\frac{1}{7}$ 94. Hvidmæhrn, S. of Rønne. — 9,5 meters. — Stones. — *Fucus vesiculosus*, (*F. serratus*).
- SK. $3\frac{1}{8}$ 94. Rønne Banke: Højbratterne, $\frac{1}{8}$ mile S. of the broom. — 11,5 meters. — Gravel and stones. — *Fucus serratus*, *F. vesicul.*, (*Furcellaria* with *Ceramium*).
- SI. $3\frac{1}{8}$ 94. Rønne Banke, Lat. N. $55^{\circ}1\frac{1}{2}'$, Long. E. $14^{\circ}47\frac{3}{4}'$. — 13 meters. — Gravel. — No vegetation.
- YF. $11\frac{1}{7}$ 01. Inside Arnager Rev. — 5,5 meters. — *Fucus serratus* and *vesiculosus*, (scarce *Zostera*).
- YG. $11\frac{1}{7}$ 01. Arnager Rev, a good mile of the port. — 7 meters. — Limestone. — *Fucus vesiculosus* a. o.
- YE. $10\frac{1}{7}$ 01. Off Ølenaa, $\frac{1}{3}$ mile of land. — 10,5 meters. — Stones or rock. — *Polysiph. nigrescens*, *Furcellaria*, (*Fucus serratus*).

- SN. $\frac{6}{8}$ 94. Davids Banke. — 15 to 17 meters. — *Fucus serratus*, (*Ectocarpus*).
 — — — 24,5 to 28 meters. — Stones. — *Laminaria saccharina*.
 XZ¹. $\frac{5}{7}$ 01. — — N.W. side of the bank. — 29 meters. — Stones. — Red and brown
 Algæ, no *Laminariæ*.
 XZ². — Davids Banke — 12 to 22,5 meters. — Stones. — *Fucus serratus* (and some *Florideæ*).
 XZ³. — — — 15 meters. — Stones. — *Fucus serratus* with red and brown Algæ.
 XZ⁴. — — — 19 to 20,5 meters. — *Laminaria saccharina* in abundance, *Fucus*
serratus.
 XZ⁵. $\frac{5}{7}$ 01. Hammer Odde S.E. by E. 7 miles. — 41 to 43 meters. — Firm clay with a few
 small stones. — No plants.
 SM. $\frac{6}{8}$ 94. N. of Hammeren, Lat. N. 55°18,8', Long. E. 14°46'. — 24,5 meters. — Sand. — No
 vegetation.
 SL. $\frac{5}{8}$ 94. Off Allinge. — Ca. 5,5 to 11,5 meters. — Rock and stones. — *Fucus vesiculosus*,
Ceramium rubrum, *C. vertebrale*, *Sphacelaria racemosa*.
 SO. $\frac{6}{8}$ 94. Off Gudhjem. — 5,5 to 11,5 meters. — Rocky ground. — *Florideæ*, in particular
Ceramium rubrum f. *ballica*, *C. vertebrale*, *Phyllophora membranifol.*, *Ph. Brodiaei*, *Fur-*
cellaria, *Dictyosiphon*, *Fucus serratus*.
 SP. $\frac{6}{8}$ 94. $\frac{1}{4}$ mile N. by W. $\frac{1}{2}$ W. of Møllenakke by Svaneke. — 28 meters. — Gravel. — No
 vegetation.
 SQ. $\frac{6}{8}$ 94. Close S. of Broens Rev. — 9 meters. — Rocky ground. — *Fucus serratus*, (very
 few *Florideæ*).
 YD. $\frac{6}{7}$ 01. The double broom at Salthammer Rev W. $\frac{1}{4}$ S. 1 mile. — 19 meters. — Stones. —
 Abundant vegetation of red and brown Algæ: *Ectocarpus littoralis*, *Delesseria sanguinea*,
Rhodomela, *Polysiphonia elongata* var. a. o.
 YC. $\frac{6}{7}$ 01. The double broom at Salthammer Rev N.W. $\frac{3}{4}$ N. $1\frac{1}{2}$ miles. — 24,5 meters. — Rather
 rich vegetation of *Ectocarpus littor.*, *Rhodomela*, *Polysiph. elongata* var. a. o.
 YA. $\frac{6}{7}$ 01. Dueodde light-house W. $5\frac{3}{4}$ miles. — 37,5 meters. — *Rhodomela*, *Sphacelaria race-*
mosa, *Furcellaria*, *Deless. sinuosa*.
 YB. $\frac{6}{7}$ 01. Dueodde light-house W. 6 miles. — 43,5 to 45 meters. — Stones. — No plants.
 SV. $\frac{8}{8}$ 94. Nordvestgrund by Christiansø. — 30 to 32 meters. — Rocky ground. — No vegetation.
 SX. $\frac{8}{8}$ 94. That by Christiansø. — 0 to ca. 15 meters. — Abundant vegetation.

List of stations arranged chronologically, with indication of the waters
 where they are situated.

July 1890.	A—D	Ks.	Aug. 1891.	AI—AN	Lb.	Sept. 1891.	BS—BV	Sb.
Sept. —	E—M	Lf.	— —	AO—AT	Sa.	— —	BX—CC	Sf.
— —	N—S	Sm.	— —	AU—AX	Lb.	— —	CD—CF	Sb.
— —	T	Sb.	— —	AY—BF	Sa.	— —	CG	Sf.
— —	U—V	Sf.	— —	BG	Ks.	— —	CH—CI	Sb.
— —	X—Y	Sb.	— —	BH—BO	Km.	— —	CK—CR	Sm.
Aug. 1891.	Z—AG	Sb.	— —	BP	Kn.	May 1892.	CS	Su.
— —	AH—AI ¹	Sa.	Sept. —	BQ—BR	Su.	— —	CT—CZ	Sf.

May 1892.	DA—DI	Lb.	Sept. 1893.	MM—MN	Sb.	July 1895.	VL—VS	Kn.
— —	DJ—DK	Sa.	— —	MO—MY	Sa.	— —	VT—VX	Kn.
— —	DL—DT	Sb.	— —	MZ—NB	Ks.	— —	VY—XA	Ke.
— —	DU—DV	Bw.	— —	NC—ND	Km.	— —	XB—XF	Kn.
— —	DX—DY	Lb.	— —	NE—NK	Kn.	Aug. —	XG	Kn.
— —	DZ—EB	Sf.	— —	NL—NM	Ks.	July 1896	XH—XI	Kn.
June —	EC—EG	Lb.	Jan. 1894.	NN—NU	Sb.	July 1899	XK—XL	Kn.
July —	EH—EP	Ks.	March —	NV—NX	Lb.	— —	XM—XN	Lf.
— —	EQ—EY	Ke.	— —	NY—OA	Sa.	Aug. —	XO	Sk.
— —	EZ—FA	Km.	— —	OB—OF	Lb.	July 1900.	XP—XQ	Lb.
— —	FB—FD	Ke.	Apr. —	OG—ON	Su.	Aug. —	XR	Ns.
— —	FE—FH	Kn.	— —	OO—OY	Ks.	Oct. —	XS	Sb.
— —	FJ—FN	Km.	— —	OZ—PP	Sa.	June 1901.	XT—XY	Lf.
— —	FO—FP	Ks.	May —	PQ—PQ ¹	Ks.	July —	XZ—YI	Bb.
— —	FQ—FY	Sa.	— —	PR—PR ¹	Su.	Aug. —	YK—YL	Sk.
— —	FZ—GA	Lb.	July —	PS—QE	Su.	July 1902.	YM—YN	Sk.
— —	GB—GE	Sa.	— —	QF—RC	Bm.	— —	YO—YS	Kn.
— —	GF—GH	Ks.	— —	RD—RF	Bb.	Aug. —	YT	Ns.
— —	GI	Ke.	— —	RG	Bm.	— —	YU	Sk.
Aug. —	GK	Su.	— —	RH—RK	Su.	June 1904.	YV	Sa.
Sept. —	GL—GO	Kn.	— —	RL—RQ	Ks.	July —	YX	Kn.
Nov. —	GP—GY	Sb.	Aug. —	RR—RS	Ks.	— —	YY	Kn.
— —	GZ—HF	Sm.	— —	RT—RV	Ke.	— —	YZ—ZB	Kn.
— —	HG—HH	Bm.	— —	RX—SB	Su.	— —	ZC—ZD	Kn.
— —	HI	Sm.	— —	SC—SE	Bm.	— —	ZE—ZI	Ke.
May 1893.	HK—HN	Su.	— —	SF—SX	Bb.	Aug. —	ZK	Sk.
— —	HO—HS	Ks.	— —	SY—SZ	Sk.	July 1905.	ZL—ZM	Kn.
— —	HT—HV	Km.	Sept. —	TA—TF	Su.	— —	ZN—ZO	Ks.
— —	HX—IU	Ke.	— —	TG—TR	Kn.	— —	ZP	Kn.
— —	IV—KD	Kn.	Oct. —	TS—TT	Km.	— —	ZQ—ZR	Ns.
— —	KE—KG	Km.	— —	TU—TY	Kn.	— —	ZS—ZY	Lf.
— —	KH	Ks.	Jan. 1895.	TZ—UD	Kn.	— —	ZZ—aE	Ns.
— —	KI—KN	Sa.	May —	UE—UK	Sb.	Aug. —	aF—aS	Ns.
June —	KO	Su.	— —	UL—UQ	Bw.	June 1906.	aT	Lf.
July —	KP—KQ	Sm.	— —	UR—UU	Sb.	Aug. —	aU	Ks.
— —	KR—KS	Bm.	— —	UV—UX	Sf.	— —	aV—aZ	Sa.
— —	KT—LA	Bw.	— —	UY—VA	Bw.	— —	bA	Sb.
— —	LB	Sb.	— —	VB—VC	Sm.	July 1907.	bB—bG	Sk.
— —	LC—LE	Bw.	— —	VD—VF	Bm.	— —	bH—bI	Kn.
— —	LF—LG	Lb.	— —	VG—VI	Bm.	— —	bK—bL	Kn.
— —	LH—LK	Sb.	June —	VJ	Sk.	— —	bM—bN	Su.
Aug. —	LL—LP	Sb.	July —	VK—VK ¹	Km.	— —	bO—bP	Bm.
— —	LQ—ML	Lf.						

Rhodophyceæ.

A. *Protoflorideæ*.

I. Bangiales.

Fam. 1. Bangiaceæ.

- J. AGARDH (1883), Till Algernes Systematik. Tredje afd. VI. Ulvaceæ. Lunds Univ. Årsskrift Tom. XIX.
G. BERTHOLD (1881), Zur Kenntniss der Siphoneen und Bangiaceen. Mittheil d. zoolog. Station zu Neapel, II.
— (1882), Die Bangiaceen des Golfes von Neapel. Leipzig.
H. HUS (1902), An Account of the species of *Porphyra* found on the Pacific coast of North America. Proc. Calif. Acad. sc. 3. ser. vol. II No. 6, San Francisco.
H. KYLIN (1907), Studien über die Algenflora der schwedischen Westküste. Upsala.
FR. OLTMANNS (1904), Morphologie und Biologie der Algen, I, p. 529—534.
FR. SCHMITZ (1894), Kleinere Beiträge zur Kenntniss der Florideen. V. La Nuova Notarisia, Ser. V, p. 717.
— (1896), Bangiaceen. Engler-Prantl, Natürl. Pflanzenfam. I, 2, p. 307—316.

With regard to the natural history of the *Bangiaceæ* reference may be made to the above-quoted works of BERTHOLD, SCHMITZ and OLTMANNS; I wish only to make some remarks on the spores produced asexually. BERTHOLD named them “neutral spores”, a name in my opinion but little applicable, as these spores cannot be said to be more neutral than the carpospores. SCHMITZ named them monospores as they are produced by the whole contents of a cell, but the carpospores were given by him the same name, and consequently this was not a name peculiar to the spores produced asexually. Besides, it seems to me more reasonable to compare the cell, which after division produces a number of spores, with the tetrasporangium in the *Florideæ*, than to compare the daughter-cell the contents of which become a spore with the monosporangium of *Chantransia*, for the fact is that the spores in the tetrasporangium are also separated by cell-walls. If the term monospore might be used within this family, it must be for the cases where one spore only is produced by each originally vegetative mother-cell (e. g. *Gonio-trichum*, *Erythrotrichia*). When more than one spore are produced by a mother-cell, it might be desirable to give them the same designation as the tetraspores of the *Florideæ*, but against that we have the fact that the number of spores is not fixed and may be reduced to one. In order to avoid a long designation the spores produced without sexual process may be named gonidia. According to their mode of development the family may be divided into the following sections.

1. *Bangia*æ. Gonidia arising by division (or also without division) from an originally vegetative mother-cell.
 - FronD filiform *Bangia*.
 - FronD flat *Porphyra*.
2. *Erythrotrichia*æ. Gonidia arising in special monosporangia, cut off by a curved wall in a vegetative cell.
 - FronD erect, filiform *Erythrotrichia*.
 - FronD first cushion-like, thereafter vesicular, ruptured and expanded in a monostromatic plane *Porphyropsis*.
 - FronD consisting of creeping branched filaments, more or less confluent to a monostromatic disc. *Erythrocladia*.
 - (FronD a monostromatic parenchymatous disc. *Erythropeltis*).
3. *Goniotrichia*æ. Gonidia arising without cell-division.
 - Gonidia naked *Goniotrichum*.
 - Gonidia provided with cell-wall *Asterocytis*.

Bangia Lyngb. emend.

1. *Bangia fusco-purpurea* (Dillw.) Lyngb.

LYNGBYE Hydr. p. 83, tab. 24 C; HARVEY Phyc. Brit. pl. 96; REINKE in Pringsh. Jahrb. 9. Bd. p. 274 tab. 12; BERTHOLD (1882) fig. 12—14; KYLIN (1907) p. 107.

Conferva fusco-purpurea Dillw. Brit. Conf. pl. 92.

Bangia atro-purpurea (Roth) β , *fusco-purpurea* (Dillw.) Ag. Syst. p. 76; Fl. Dan. tab. 1841; J. AGARDH (1883) p. 36.

In 1806 ROTH described (Catal. bot. III p. 208), under the name of *Conferva atro-purpurea*, a filamentous Alga found in a water-mill at Bremen; it was referred to the genus *Bangia* by LYNGBYE and was found in similar localities at many other places in Europe. Three years later, DILLWYN described a somewhat similar species, *B. fusco-purpurea*, first found on the British shores, and largely distributed on the Atlantic and Mediterranean shores. The resemblance between the two species, however, was so great, that LYNGBYE referred ROTH's species as a variety to *B. fusco-purpurea*, while C. AGARDH conversely regarded *B. atro-purpurea* as the main species and *B. fusco-purpurea* as variety. The latter view was also maintained by J. AGARDH, who, however, expressly distinguished the freshwater form from the marine form while the older AGARDH only took the colour into consideration. I shall not enter on the question of the relation of these species, but like most of the marine phycologists record the marine species under DILLWYN's name. The distribution of the species on the Danish shores does not favour the supposition of a gradual transition to the freshwater form, as it does not occur in water of low salinity.

The plant is at first a filament consisting of a single row of cells, and fixed at the base by rhizines, which grow downwards from the lower cells in the common outer-wall (REINKE l. c. fig. 1). In this form the plant can attain a considerable size, but sooner or later longitudinal walls occur, which have a more or less radial position and which divide the articles into wedge-shaped cells.

According to BERTHOLD (l. c. p. 9), the first stage in the formation of the "neutral spores" or gonidia begins with the protoplasmic body increasing in mass, while at the same time shining globules occur, which are soluble in water and are stained brown by iodine, more rarely minute starch-grains, and the pyrenoid occupies the centre of the cell. During the first stages of these changes one or two divisions take place and then the cell-bodies are set free as spores. BERTHOLD does not indicate, if these divisions are only anticline or if they can also be pericline. According to SCHMITZ (1896 p. 311), these spores can also arise without division from the whole of the contents of a vegetative cell. The first dividing wall of the fertilized carpogonium is, according to BERTHOLD (l. c. p. 16), parallel with the surface of the thread, while the following are radial, and we thus have as result eight carpospores in vigorous threads. These though of very variable size are smaller than the gonidia, and differ from the latter, according to BERTHOLD, by containing minute granules of starch and a smaller and less lobed chromatophore; they show amoeboid movements though slower than those of the other spores.

It will be understood from the above, that it is not always easy to decide if we have to do with gonidia or with carpospores, especially in examining dried specimens, and when the direct traces (e. g. canal) of the fecundation process have disappeared. — Male filaments I have met with rather seldom, though at different seasons, but most frequently and best developed in spring. While the formation of spermatia ordinarily takes place very uniformly, all cells in the same part of the thread being in the same stage of development, some threads collected in July at Frederikshavn showed a more irregular disposition, the antheridia being intermingled with cells which were little or not at all divided, and which undoubtedly would not reach to the production of spermatia. They could not be supposed to be carpogonia as there were no spermatia attached outside them and they showed no periclinal walls. BERTHOLD states also, that the species is dioecious "mit wenigen Ausnahmen".

Female filaments with attached spermatia I have met with in February, April and May, and I have also several times been able to see the fine fertilization tube, though it seems to disappear rapidly along with the spermatia. In fig. 1 some fertilization tubes are still visible after the disappearance of the spermatia. The carpogonia may appear in thin threads, which are only divided by a few longitudinal walls, as well as in thicker filaments the articles of which consist of several cells (fig. 1). Fig. 2 *A* and *B* show transverse sections of female filaments which, seen from the side, showed spermatia attached to the surface. The cells, which have been divided by periclinal walls, must be supposed to be fertilized carpogonia. How many cells belong to the individual cystocarps in fig. 3 *B* is difficult to decide; it seems that vegetative periclinal divisions have also taken place, either before or after fertilization. I have only seldom seen carpospores containing starch-grains, e. g. in specimens collected at Hirshals in April, showing distinctly the process of

fertilization (fig. 1). In dried specimens I could not see distinct starch-grains, but only indistinctly limited spots giving blue-violet colour with iodine.

Gonidia seem to occur much more frequently than the carpospores on our coasts, as I have met with the species at all seasons and most frequently with spores, which must be regarded as gonidia. These spores may arise in very thin threads whose articles show only one longitudinal wall, but their origin can also take place in thick threads with numerous longitudinal walls. As a rule two or four spores are produced by each mother-cell; most frequently I found no starch in these spores, but in a few cases I observed numerous very small starch-grains in spores which were undoubtedly gonidia (Thyborøn and Skagen, July). In May I saw the spores escape from threads recently collected at Hirschals, a process that took place very rapidly; amoeboid movements I did not observe, but the chromatophore showed alterations of form. In one spore it had taken a globular form and was sharply defined; shortly afterwards it became angular and seemed about to take the ordinary stellate shape, but it soon took again the rounded form. In other cases these spores showed the amoeboid movements.

Fig. 1.
Bangia fusco-purpurea. Fragment of female filament with fertilization tubes and a few spermatia still adhering.
390 : 1.

This species occurs at ordinary high-water mark and higher, so that it is frequently out of the water and even dried up and in great measure only wetted by the spray of the waves. It is therefore easy to understand why it is not commoner than it is at the Danish shores, where the tide is mostly insignificant; in unfavourable periods with continual low water and calm, dry weather it would be in danger and would be killed at all the places, where it is not protected by special conditions against desiccation of long duration. At Frederikshavn it grows chiefly on the outer sides of the moles, where with a westerly wind the level of the sea is proportionally high, while with an easterly wind the level is low but the mole ordinarily washed by the waves. The most dangerous condition for the *Bangia* vegetation is a fairly long period of easterly winds with the wind so light, that this vegetation is not reached by the waves, especially when the weather at the same time is bright and dry. Its occurrence is therefore very different, not only at various seasons, but also in different years. In winter it is very abundant, but the critical period of the spring will every year kill a greater or smaller part of it and on the duration and intensity of this period depends to what degree that will take place. In summer for example it occurs at

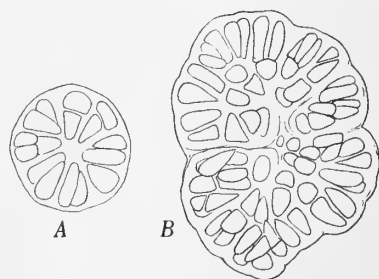


Fig. 2.
Bangia fusco-purpurea. Transverse sections of female threads with cystocarpia. 200 : 1.

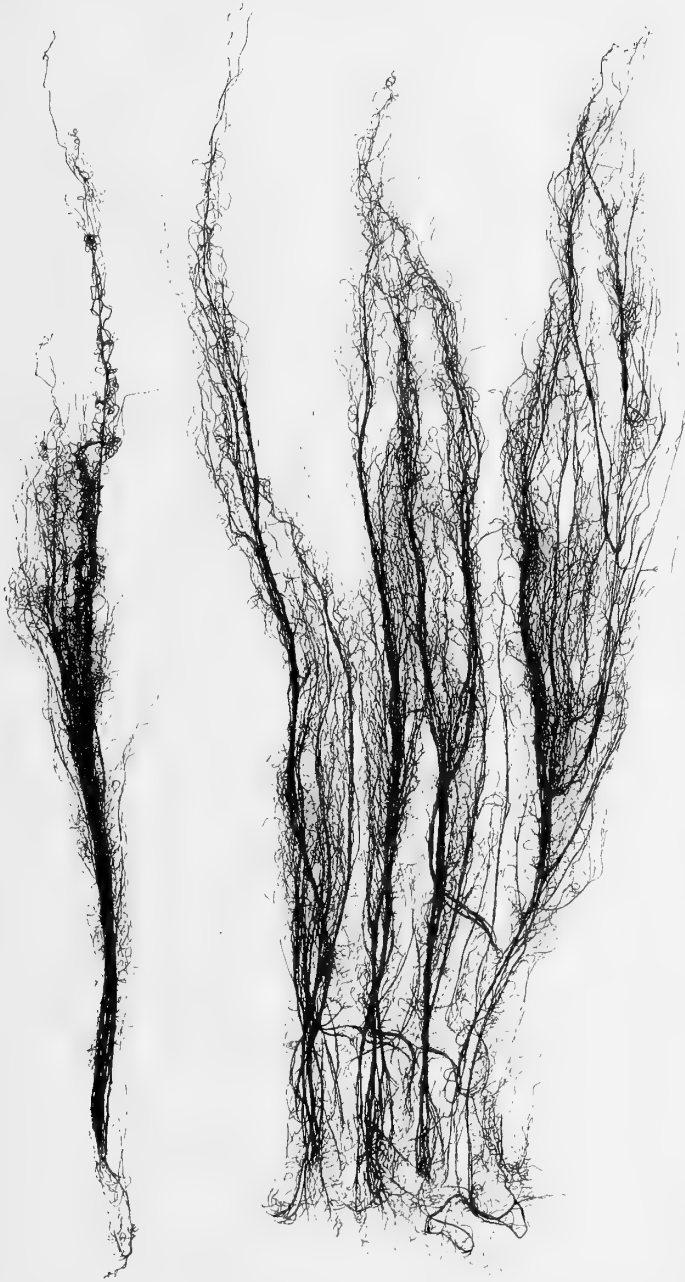


Fig. 3.

Bangia fusco-purpurea. Specimens collected at Middelfart (Kongebro)
March 1894. After photograph, natural size.



Fig. 4.

Bangia fusco-purpurea, growing on *Phyl-
litis zosterifolia*, mole at Hirshals, Aug.
Phot., nat. size.

Frederikshavn in some years only in small quantities, while in others it forms extensive growths especially on the outer side of the south mole, as in the beginning of August 1902. In the Little Belt it completely disappears in summer, at all events in certain years (e. g. 1901), while in spring it is often abundant and luxuriant. In March 1894 it was so well developed there, that I have never found it better developed on the Danish shores; the threads attained a length of 14—15 cm and were above thick and curled (fig. 3). In April 1904 I searched for it in vain at the same place. This is the most southern locality known on the Danish shores.

Localities. **Ns:** Thyborøn, groin No. 58. — **Sk:** Hirshals, on the mole and on a boulder on the shore, observed in the months April to August, may occur abundantly still in July. Has also been found growing on *Phyllitis zosterifolia* (fig. 4). Greatest length of the threads observed here ca. 7 cm. — **Lf:** Harbour of Lemvig (?); Thisted; Glyngøre. — **Kn:** Harbour of Skagen; Busserev by Frederikshavn (April and July); harbour of Frederikshavn. — **Ke:** Harbour of Gilleleje, Febr. and May, ca. 1 cm long. — **Lb:** Harbour of Fredericia (Hofm. Bang, !); harbour of Middelfart, stone-slope west of the harbour, March and April, Kongebro.

Bangia pumila Aresch. (DARBISHIRE, Ueber *Bangia pumila* Aresch., eine endemische Alge der östlichen Ostsee. Wiss. Meeresuntersuchungen, N. F. 3. Bd., Abt. Kiel 1898, S. 25) which according to DARBISHIRE is readily distinguished from *B. fusco-purpurea* as well as from the fresh-water *B. atro-purpurea*, and which, as far as known, is endemic in the Baltic, has not been met with hitherto in the Danish shores, though I have sought for it, particularly on the shores of Bornholm. It differs from *B. fusco-purpurea* in particular in that the articulation of the frond is still distinct in the older frond, which is divided by longitudinal walls, and through smaller cystocarps. As it has been found at Swinemünde and at Dantzic, there is reason to believe that it may also be found on the Danish Baltic coasts.

According to KYLIN (1907 p. 109), however, this species has been found by ARESCHOUG not in the Baltic but “in den innersten Buchten von Göteborg”. This author regards it as being not a distinct species but probably only feebly developed specimens of *B. fusco-purpurea*.

Porphyra Agardh.

1. *Porphyra umbilicalis* (L.) J. Ag. (Plate I and II fig. 1—3.)

J. Agardh (1883) p. 66.

P. laciniata (Lightf.) Ag.; Thuret in Le Jolis Liste des Alg. mar. de Cherbourg 1864, p. 99, Janczewski, Études anat. sur les Porphyra. Ann. sc. nat. Ve sér., t. 17 1873, p. 241, pl. 19 fig. 25—26; Thuret et Bornet, Études phycologiques, 1878, pl. 31, p. 58.

f. *linearis* (Grev.) Harv.

P. linearis Greville, Algæ britannicæ 1830 p. 170 tab. 18; Kützing Tabulæ phycologicæ XIX tab. 79; J. Agardh, l. c. p. 71; Le Jolis Algues marines de Cherbourg No. 96; Kylin (1907) p. 111.

Ulva purpurea β, *elongata* Lyngb. Hydr. p. 29.

P. vulgaris forma, Harvey Phycologia Britannica pl. 211, fig. 2—3; Thuret in Le Jolis Liste p. 99.

P. hiemalis Kylin, (1907) p. 112 Taf. 3 fig. 2.

f. *vulgaris* (Ag.) Thur. in Le Jol. Liste p. 99.

Ulva purpurea Roth Catalecta I p. 209, Lyngb. Hydr. p. 29.

Porphyra vulgaris Agardh, Flora 1827 II p. 642, Icones Algar. tab. 28; Harv. Phyc. brit. pl. 211; Aresch. Alg. Scand. exs. No. 261.

f. *laciniata* (Lightf.) Thur. in Le Jolis Liste p. 99.

Ulva umbilicalis Lyngb. Hydr. p. 28; Flor. Dan. tab. 1663.

P. laciniata Ag. Syst. Algar. p. 191, Icones Algar. pl. 27; Harv. Phyc. Brit. pl. 92; Areschoug Alg. scand. exs. No. 116 and No. 260.

P. laciniata var. *umbilicalis* Ag. Ic. Algar. tab. 26.

With regard to the limitation of the species I agree with THURET (in LE JOLIS Liste), but I follow J. AGARDH in adopting the specific name of LINNÉ, as it is the oldest and besides not less significant than LIGHTFOOT's name *laciniata*.

As to the f. *linearis*, the views of authors have been divergent. It was HARVEY (Phyc. Brit. pl. 211) who first showed, from observations in nature, that it is only a juvenile winter-form, which later passes over into the broader form, and this has been confirmed later by THURET and others. J. AGARDH regards it however as a distinct species, emphasizing that it occurs not only in winter but also in spring. KYLIN follows this author but without discussion of his view. Having observed this form in nature in winter and spring, I cannot but come to the same result as HARVEY and THURET. In winter this species is abundant on the moles at Frederikshavn, on the inner as well as the outer side, and it occurs then mainly in rather narrow forms, which pass gradually and evenly into specimens which correspond exactly with *P. linearis* Grev. While the latter is said to attain only a length of a few inches, specimens more than 20 cm. long but less than 1 cm. broad, for the rest fully typical, were commonly found. The largest specimen I have collected is without the basal portion but is notwithstanding 43 cm. long with a breadth of only 0,8 cm. The typical specimens of f. *linearis* have a well developed stipe, rounded base and the margin a little or not undulated. In some broader specimens the margin becomes more undulated, the base broader and cordate (Plate II fig. 1—3). Such specimens agree with KYLIN's *P. hiemalis*; the only difference between this and *P. linearis* seems to me to be, after KYLIN's description, besides the somewhat greater dimensions, the fact, that the sporocarps form long narrow sori. This I have also observed in some of the specimens mentioned here (Plate II fig. 1), but by no means in all, and on the other hand it occurs also in broad specimens of *P. umbilicalis* (Plate I fig. 3), and therefore it cannot be used as a distinguishing character between the forms of this species.

These narrow forms occur in great quantity in winter on the moles of Frederikshavn, particularly on the outer side of the outer moles, at high level, and also on moles and groins on the west coast of Jutland. In spring, when easterly winds occasion low water, this fact in connection with the increasing dryness of the air and the strong sun will cause these *Porphyra* plants to a great extent to die. The individuals surviving this critical season are those growing at a rather low level or in places which are protected by particular conditions against drying up during low water. In growing older the frond of these individuals increases more in breadth than in length, and the same frond may then pass in development

from *f. linearis* through *f. vulgaris* to *f. laciniata* (comp. THURET in LE JOLIS Liste p. 100). In *f. vulgaris* the longitudinal axis of the frond is much longer than the radii going outwards or downwards, but under the continued growth of the frond in transverse direction this difference diminishes and at last entirely disappears, the frond obtaining an approximately orbicular outline, at the same time becoming more or less lacinated and, on account of the continuous transverse growth, much radially folded (Plate I fig. 2). The point of attachment in this stage is only apparently, not really central and umbilicate, as supposed in the older descriptions and drawings (LINNÉ, Spec. plant. II 1763, and DILLENIIUS, Hist. muscor. 1741, tab. 8).

Though the *f. linearis* normally disappears in spring on the Danish shores, it can however be found much later in the year if rarely. Thus I have met with it on the outer side of the northern mole of Frederikshavn, near the entrance of the harbour, at a place where the sea is as a rule agitated, in July 1895 and September 1892. The specimens found in September were very well developed, up to 30 cm. long, 0,5 to 1,3 cm. broad, fully typical, only of a lighter colour than the specimens occurring in winter. These discoveries, however, may be very rare exceptions, for I have otherwise never found this form in summer at Frederikshavn, one of the best investigated localities in Denmark, as little as in any other locality. ARESCHOUG has also found it in August on the shore of Bohuslän (Phyc. scand. mar. p. 180).

This species has been met with in all the months of the year, and it occurs at all seasons in fully developed specimens. It can probably attain an age of more than one year, but most of the specimens die, as said above, at a rather young age. It has been found fertile at all seasons, and then nearly always with sexual organs (or carpospores). While several authors state that the species is as a rule dioecious (THURET, BERTHOLD, KYLIN), I have found it most frequently monoecious on the Danish shores, at all events in summer. In winter only have I found the specimens generally dioecious, particularly *f. linearis* (Plate II fig. 2—3). In the specimens met with in summer the frond is generally divided by a longitudinal limiting line into a male and a female portion, distinguishable thereby that the margin of the first is yellowish white, that of the second purple. The limiting line is most often remarkably straight; it is very distinct towards the margin, while downwards it becomes indistinct and finally vanishes on reaching the sterile portion of the frond (Plate I fig. 1). The male and female parts of the frond are in some cases of equal size, in others the male or the female is broadest. Even the narrow winter forms can be monoecious and show a well marked limiting line (Plate II fig. 1). According to HUS (1902, p. 197), the sporocarpia and antheridia in *Porphyra laciniata (umbilicalis)*, when they are developed in the same frond, "occur in patches very much as in *P. perforata*". If that is really normal to the species of the Pacific coast, it must be supposed that it is a different species from the European *P. umbilicalis*.

The decoloration of the developing antheridia generally takes place gradually from the margin inwards. Some few specimens from Helsingør showed however, at some distance from the margin, some lighter spots, reminding one of the an-

theridial spots in *P. leucosticta*. They were found to consist of antheridia earlier in their development than the surrounding antheridia, which were still in division.

As first shown by BERTHOLD (1880 and 1882), the spermatia attach themselves to the female portions of the frond, and a fine fertilization canal is formed through the wall of the carpogonium-cell. These fertilization canals contain a thin strand of protoplasm, which is still to be seen a long time after the fertilization, while the exhausted spermatium quickly disappears. Their number is often remarkably great, much greater than that of the carpogonia (fig. 5 A—C). It is evidently a very common case that several fertilization tubes are introduced to one carpogonium.

The fertilised carpogonium divides, as is well known, by a transverse wall; thereafter follow often one or two further transverse walls, whereupon arises a 3- or 4-celled prismatic body which thereafter may be further divided by differently orientated walls (fig. 5 D, F). Such divisions result no doubt in cystocarps with numerous carpospores, while the typical case is regarded to be eight carpospores in two layers. Extraordinarily large cystocarps, containing a great number of spores, were found in specimens collected in the harbour of Skagen in April, the frond of which was unusually thick, 90 to 115 μ (fig. 5 D—E). Comp. BERTHOLD (1882) fig. 10.

In a number of specimens (52) collected in March on groins near Thyborøn, nearly all belonging to f. *linearis*, a few to f. *laciniata*, I found only cystocarps containing about 8 carpospores arranged in two layers, but in no case could spermatia or fertilization tubes be observed, and none of the plants contained antheridia. As the spores in all cases examined resulted from a division parallel to the frond, it may be supposed that we have here a case of apogamy, if it should not be found that the monospores can result also from such divisions.

The development of the cystocarps is as a rule uniformly progressive from the margin of the frond inward. Sometimes, however, the maturation takes place

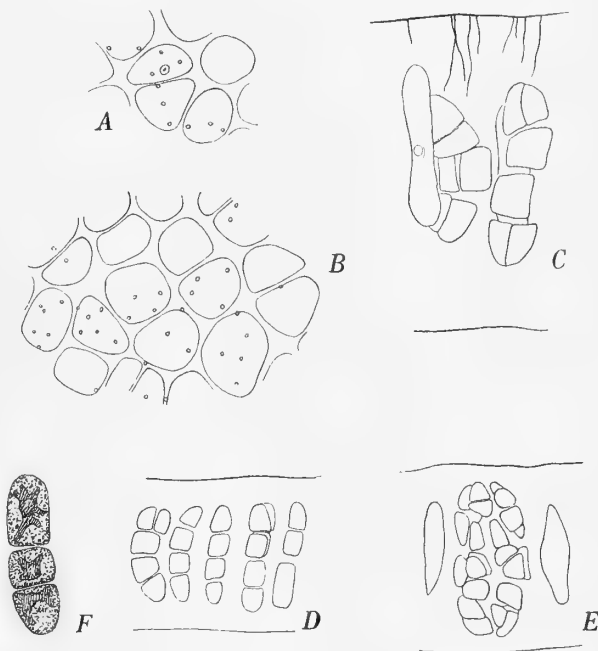


Fig. 5.

Porphyra umbilicalis. A—E, specimens from the harbour of Skagen, July. A and B, parts of frond seen from the surface: the cell-walls and, at a higher level, the fertilization tubes and in A a spermatium are shown. C, part of frond with fertilization-tubes and cystocarps in transverse section. A—C 390:1. D and E, transverse sections of frond with cystocarps from the same locality, April. 230:1. F, incompletely divided cystocarp, Frederikshavn December. 500:1.

more rapidly in some irregularly ramified spots than in the surrounding parts, and these spots appear therefore with a deeper red colour, as observed earlier by BERTHOLD (1882 p. 16). As mentioned above, this is to be found in broad as well as in narrow forms, and it cannot be used as distinctive character between them.

The carpospores contain as a rule numerous minute starch-grains which are stained brown-violet with iodine. I have also found fertilised carpogonia containing starch before dividing, but on the other hand I have also seen carpospores without starch.

The gonidia result, according to BERTHOLD, from one or two divisions perpendicular to the plane of the frond, and the frond after these divisions is consequently one-layered as in the vegetative state. These spores seem to occur much rarer on the Danish shores than the carpospores. I have not had occasion to observe this kind of fructification in fresh specimens or in specimens preserved in alcohol; I have only met with a few herbarium specimens which seemed to contain gonidia. Thus, a specimen collected in the harbour of Sæby in September was without sexual organs, rather uniformly rose-coloured, and consisted merely of a single layer of cells of the same size as the vegetative cells, but with richer, more granular plasmatic contents, which stained brown-violet to nearly dark with iodine, without however showing distinct starch-grains. Further, the cell-bodies were much disposed to leave the cell under the softening.

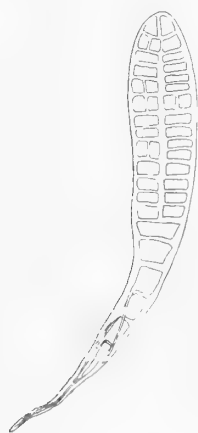


Fig. 6.
Porphyra umbilicalis.
Germinating plant,
growing on *Nemalion*
multifidum. 240:1.

The germinating plants are, as shown by THURET and BORNET (1878 p. 58), at first filiform, but at an early period longitudinal divisions and rhizines arise. The apical cell is early divided by a longitudinal wall, while the inferior part of the thallus is still filiform (fig. 6).

The species grows, on the Danish shores, about at ordinary water level, or at some distance above it, especially in winter, or a little under it, but hardly under the lower water-level. When occurring in the *Fucus*-zone, it grows only in the upper part of it. At Esbjerg it occurs only in the upper part of the littoral region. It thrives best where the salinity of the water is comparatively high and the locality tolerably protected. It attains therefore its greatest size at Esbjerg and in the Limfjord, where it becomes more than 40 cm. long, while it is smaller on the more exposed groins and moles at Thyborøn and Hirshals. In the most southern localities in the seas within Skagen I found the following maximal sizes of the frond: in Little Belt (Middelfart) 24 cm., in Great Belt (Smørstakken) 29 cm., in the Sound (Helsingør) 12 cm. Most of the Danish places for this species are moles; the natural habitats are emerging reefs and boulders near land. It grows also on wood, more seldom on *Fucus*; young specimens have been found growing on *Nemalion multifidum*.

Localities. **Ns:** Nordby, Fanø (C. Rasch, abundantly in the *Fucus*-zone!); Esbjerg (Børgesen, on moles and embankments in the upper half of the littoral region!); groins by Thyborøn (in spring chiefly *f. linearis*, in summer only broader forms. — **Sk:** Hirshals (on the mole and on boulders on the shore, in spring *f. linearis* abundantly above high-water mark, in summer the species disappears entirely or almost entirely). — **Lf:** Harbours of Lemvig, Struer and Thisted; Aalborg, harbour and piers of bridge (!, Th. Mortensen and unknown collector in herb. C. Rosenberg); Nørre Sundby; Hals. — **Kn:** Harbour of Skagen; Busserev (with *Bangia* near high-water level, small specimens in April; harbour of Frederikshavn (in winter *f. linearis* abundantly, mainly at high-water level, in summer only broader forms, as a rule in small quantity); harbour of Sæby. — **Ks:** Harbour of Grenaa. — **Sa:** Kyholm (upper *Fucus*-zone, with *Ralfsia*); Aarhus, harbour, and on boulders on the shore by Riis Skov. — **Lb:** Harbour of Bogense (!, Børgs.); Fredericia (Hofm. Bg., Joh. Lange,!); Strib; harbour of Middelfart (Hofm. Bg., C. Rosenb.,!), Kongebro. — **Sb:** Harbour of Lohals; Smørtakken. — **Su:** Harbour of Helsingør.

2. *Porphyra leucosticta* Thuret. (Plate II fig. 4—13.)

Thuret in Le Jolis, Alg. mar. de Cherb. 1864, p. 100. Janczewski, Ann. sc. nat. Ve sér. t. 17, 1873, p. 241 pl. 19 fig. 1—14. Berthold (1881) p. 79. Id. (1882) Taf. 1 Fig. 1—6.

Porphyra atropurpurea Olivi in Saggi Accad. di Padova III. 1. 1791, teste De-Toni, Syll. Alg. IV. Sect. 1, p. 17. Exsic.: Crouan Alg. mar. du Finistère No. 397. Le Jolis Alg. mar. de Cherbourg No. 156.

This species which has only been met with on our most northern shores, occurs there in its typical shape but does not attain a considerable size. The largest observed specimens are (in a dried state) 10—11 cm. long, only one specimen was 16 cm. long. The longest fronds are lingulate, about 2—4 cm. broad, with rounded or more frequently cordate base, but very often the margins of the frond overlap each other below the base, particularly in the broadest specimens, in which the attachment may then become apparently umbilicate. The frond is generally entire, rarely a little lobed, the margin more or less undulated. The colour is as a rule a little more reddish than in *P. umbilicalis*, but the difference is not absolute; the two species can occur with exactly the same colour. The thickness of the frond I found to vary between 28 and 44 μ .

The specimens met with in April were all provided with sexual organs, in so far as they had attained a tolerable size. The antheridia formed the well known patches, running longitudinally in the upper part of the frond, 5—10 mm. long, 1—1.5 mm. broad. There are, however, also very small antheridial patches, originating in a group of very few mother-cells. The number of spermatia arising from each mother-cell is fairly often smaller than 64. As shown by JANCZEWSKI (l. c. p. 247), isolated cystocarps are often scattered among the antheridia. The carpogonia had very often produced a hyaline protuberance at each extremity, a state which, according to BERTHOLD, is due to the fact that the carpogonia have been obliged to wait a long time for fecundation. When all the carpogonia assume this form, the frond becomes papillose on both sides. Fig. 7 B shows a spermatium

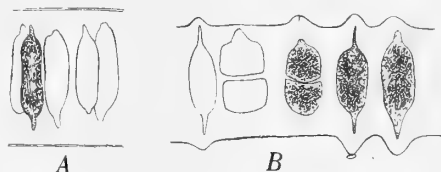


Fig. 7.

Porphyra leucosticta. Transverse sections of frond with carpogonia; in A these are not fertilized, while in B three of them are fertilized and two divided by a cross-wall. 390:1.

attached to the top of a papilla, while the adjacent carpogonium has divided by a transverse wall after fecundation; the fertilization-canal of this carpogonium is yet to be seen below. The carpogonia produce 4 or 8 spores in two layers.

This species seems to disappear during the summer. On July 2nd 1905 on the moles of the harbour of Skagen I only found some very small specimens 1—1.5 cm. high, being evidently the under part of specimens which had exhausted their spermatia and carpospores; there were namely still to be seen remnants of emptied antheridial sori and some few cystocarps containing 8 spores, while the upper border of the frond consisted of emptied cell-walls (Plate II fig. 9—13). In 1907 the species remained longer, perhaps in connection with the fact, that the summer was unusually cold with predominant westerly winds. On July 11th 1907 I found in the same locality rather large specimens, some of which showed antheridia, in part not emptied, and cystocarps. Other specimens did not show these organs and did not seem to have produced them earlier. In such a specimen the cells in the upper part of the frond had more granular contents than the vegetative cells, for which reason I am inclined to believe, that they were producing gonidia (Plate II fig. 8). These cells had a sharply limited lateral vacuole; they were not divided by walls parallel to the frond.

KYLIN (1907 p. 110 Taf. 3 Fig. 1) has established a species nearly related to *P. leucosticta* under the name *P. elongata* (Aresch.) KYLIN (*P. laciniata* var. Areschoug Alg. Scand. exsicc. No. 117), which is distinguished by its elongated form of frond with uniform breadth, its thinner frond (25—33 μ while it is said to be 33—40 μ in *P. leucosticta*), and the smaller antheridial sori; it may be added that the author found it epiphytic and fructiferous in August. It appears to me, however, to be rather doubtful if it can really be regarded as a species distinct from *P. leucosticta*; at all events, the alleged characters are hardly conclusive. As said above *P. leucosticta* has often a lingulate form (comp. Pl. II fig. 4—8), and that is so also in specimens from the coasts of France. The thickness of the frond was found, in the Danish specimens of this species, to vary on both sides of the limit given by KYLIN (see above). That the sori of antheridia in the specimens of KYLIN reached only a size of 2 mm., while they attained a length of 10 mm. in the Danish specimens, is scarcely sufficient for specific distinction. I have found no specimen on the Danish coasts fully agreeing with *P. elongata* KYLIN, the specimen most similar to it was 16 cm. long, 2 cm. broad, on the one side with a small lobe; it had a thickness of 28 μ , but the antheridial sori were long.

The plant grows on stones at the mean level of the sea.

Localities. Sk: Hirshals, on the mole and on a large boulder on the shore, April 1906.
Kn: Harbour of Skagen; it appeared contemporaneously with the construction of the harbour; it was detected by Mag. M. L. MORTENSEN, $\frac{3}{4}$ 1905, on the moles commenced the preceding year and constructed, as far as known, exclusively of stones taken on land. Later, I have found it, on several visits in April and July, on the outer and inner sides of the moles, but only or principally near land.

Erythrotrichia Areschoug.

Phyceae Scandinavicae marinae 1850 p. 209.

1. *Erythrotrichia carnea* (Dillw.) J. Ag.

J. Agardh (1883) p. 15.

Conferva carnea Dillwyn, Brit. Conf. 1809 pl. 84.

Conferva ceramicola Lyngb. Hydr. 1819 p. 144 tab. 48 D (teste specim.)

Bangia ceramicola Chauvin, Rech. sur l'org. de plus. genr. d'Algues, Caen 1842, p. 33; Harvey, Phyc. Brit. pl. 317; Hauck, Meeresalg. p. 22.

Erythrotrichia ceramicola Aresch. l. c. p. 210; Le Jolis (Thuret), Alg. mar. Cherb. p. 103 pl. III fig. 1—2!; Berthold (1882).

This species is attached to the substratum not by means of a basal layer of cells, but only by the basal cell which gives off short ramified rhizines radiating in all directions on the surface of the substratum, while the other cells of the filament produce no rhizines. In fig. 8 C the rhizines are rather irregular as the plant was attached to the border of a *Porphyra* thallus. At the base the filaments are a little thinner than higher up, but the outer cell-wall becomes by and by incrassated. The filaments often attain only a length of 0.5 cm., but where the plant thrives well it becomes at least 3 cm. long. The thickness of the filaments is 16—24 μ , a little less at the base.

The cells contain a star-shaped chromatophore with numerous narrow branches radiating in all directions, in particular downwards and upwards, and with a central pyrenoid. The nucleus is small and not always visible as it is often hidden behind the chromatophore or between its branches (fig. 8 D—F). The vegetative cells contain in general no starch; some specimens collected in Sallingsund, Limfjord, in July were however the exception in this respect, all cells containing numerous small starch grains staining blue-violet with iodine; yet the sterile cells showed not so many starch grains as the sporangia. The length of the cells in proportion to the breadth is rather variable. In specimens collected in January the cells were very short and their contents very dense; their length was always shorter than the breadth, often only a third, while in summer filaments are often met with, the cells of which are 3—4 times as long as broad and then with rather poor contents. Plants collected on Herthas Flak (Kn) in 19 meters depth in September consisted of cells of about equal height and breadth. I have only seldom met with a few cells divided by longitudinal walls and they gave one rather the impression of being somewhat abnormal. BERTHOLD (l. c. p. 25) also found longitudinal divisions very seldom, while J. AGARDH (l. c. p. 14—15) thought that they were common in this species¹.

This species has only non-sexual reproduction. The spore-mother cell is, as well known, cut off by an oblique wall at the upper end of a cell which is not different in form from the vegetative cells. Its formation begins with the nucleus

¹ It may be doubtful, whether all that is referred to this species by this author, belongs really to it, as for inst. his Tab. I fig. 8, which represents a polysiphonous proliferous filament.

dividing into two, the one lying over the other at the one side of the cell. Then the chromatophore divides after a longitudinal plan into two of unequal size lying side by side (Fig. 8 *D*); the larger later moves upwards and is taken up in the spore together with the upper nucleus (Fig. 8 *E, F*). In the lower chromatophore the pyrenoid is very small and indistinct shortly after the division, while the upper contains a large and distinct pyrenoid; it is therefore probable that the original pyrenoid passes undivided over into the larger chromatophore, while a new pyrenoid is formed in the smaller. The fructiferous cells contain many small starch-grains which stain dark-violet with iodine; they are to be found in the sporangia as well as in their sister-cells. The sporangium is in general smaller than its sister-cell;

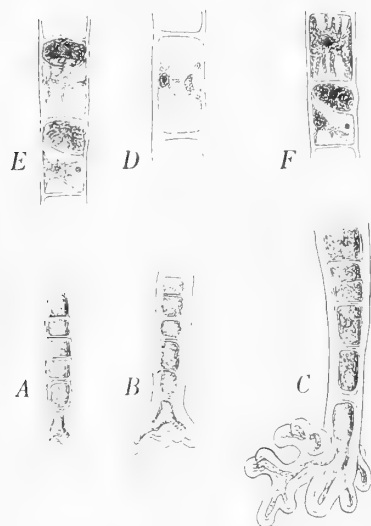


Fig. 8.

Erythrotrichia carnea. *A-C*, young plant and bases of plants attached to *Porphyra*. 380:1. *D-F*, fructiferous cells; in *D* the chromatophore and the nucleus have recently divided. in *E* and *F* the sporangial cell has been cut off. 412:1.

when the mother-cell is very short, however, they can be of equal size or even larger. As shown by THURET and BERTHOLD, the under-lying cell, after the evacuation of the spore, expands and occupies the place of the original mother-cell, and the process of spore-formation may be repeated.

The plant has been found in almost all Danish waters excepted the Baltic, as a rule, however, only in small quantities and therefore not conspicuous. In greater quantity only found at Struer, in the Limfjord, (Sept. 1890) and in the harbour of Frederikshavn (particularly in August 1891 and July 1896). It is a summer Alga, nearly exclusively met with in the months July to September; it has however also been collected in winter (Nov. and Jan.). It has been found fructiferous in all the months named. It does not like much agitated water; it has been found most frequently and in greatest quantity in harbours, on piers and the like, in small depths, but it has been found down to 19 meters. It is always epiphytic and has been found

growing on a number of different Algæ, e. gr. *Polysiphonia nigrescens* and *violacea*, *Ceramium rubrum*, *Brongniartella*, *Bryopsis*, *Porphyra umbilicalis* and many others.

Localities. **Sk:** SY, off Løkken, 13 meters. — **Lf:** Harbour of Struer; Sallingsund, at Glyngøre and off Snabe, 4—6 meters; LS, off Arnakke, 7 meters; MI, off Ejerslev, 4 meters. — **Kn:** Herthas Flak, 19 meters, (Børgs.); harbour of Frederikshavn; Borrebjergs Rev; Nordre Rønner; GM, 6 meters. — **Km:** BL, 9,5 meters; BH, off Gjerrild Klint, 4 meters. — **Ks:** Holbæk Fjord. — **Sa:** Kalø Rev; Hofmangave (Lyngbye, Hofm. Bg.). — **Lb:** Harbour of Middelfart. — **Su:** BQ, off Ellekilde, 5,5 meters; PZ, E. of Hveen.

Porphyropsis gen. nov.

Frons initio pulvinata parenchymatica, dein vesiculosa et rupturâ in membranâ monostromaticâ expansa. Sporæ (gonidia), ut in *Erythrotrichia*, divisione obliqua in cellulis frondis gignuntur. Reproductio sexualis ignota.

1. *Porphyropsis coccinea* (J. Ag.).

Porphyra coccinea J. Agardh, Noyitiæ fl. Svec. 1836 p. 6 (without description); J. Areschoug, Phyc. Scand. mar. 1850 p. 181 tab. I D; J. Agardh (1883) p. 56; P. Kuckuck, Bemerk. z. mar. Algenveg. Helgoland II, 1897, p. 390 fig. 13, 14.

This pretty little Alga, which has been referred till now to the genus *Porphyra*, I have met with only at three places in the eastern Kattegat, at the two only in extremely small quantity. As its mode of fructification has been hitherto unknown, its systematic position has remained uncertain, as pointed out by KUCKUCK, who showed that the chromatophore has no central pyrenoid as in the other species of *Porphyra* but that it forms a much divided parietal plate. It will be seen from the following that this plant also in other respects differs so much from the typical species of *Porphyra*, that it must be removed from this genus. Thus the development of the frond is quite different; whereas in *P. umbilicalis* this begins as a filament which early becomes leaf-like, being divided by longitudinal walls, in *Porphyropsis coccinea* the frond is at first cushion-like, parenchymatous and composed of more than one layer of cells. The frond increases in height and becomes globular and vesicular. Such a condition is to be seen in Fig. 9 A. As this and other similar plants were growing together with more advanced stages of this species and as they much resembled the lower, basal portions of the latter, I conclude that they belong really to the same species. The plant figured is nearly hemispherical with a lobed plane of attachment, in the margin of which the cells are somewhat elongated. The upper part of the frond consists of a layer of cells which are actively dividing by anticlinal walls; the growth caused by these divisions has caused a separation of this cell-layer from the cells lying within, and the continued growth must necessarily cause the plant to become more and more vesicular. A rupture of the vesicle must, however, take place at an early period, for small individuals occur with an irregularly lobed monostromatic frond tapering downwards and ending in a cushion-like, basal disc resembling the under part of fig. 9 A. In consequence of this development the young frond is usually more or less cup-shaped; in particular, the margins immediately above the basal cushion are most frequently bent inwards to the same side. The expanded frond projects from the one side of the basal cushion, the greater part of which is situated at the hollow side of the young frond. On the side of the cushion opposite to the frond are often to be seen irregular projections representing the lower border of the split by which the monostromatic frond has arisen. The lap visible below on the left in fig. 9 C belongs undoubtedly to this category. The formation of the split itself I have unfortunately not observed; probably a transverse split is formed on the one side of the vesicular frond. The development here described is not entirely unknown; J. AGARDH (1883 p. 56) describes the young plants thus: "Hoc modo plantam nondum lineam altam fere hemisphaericam vidi, nempe lamina marginibus ita involuta ut media pars sursum spectaret, apice marginibusque ad ambitum hemisphaerii decumbentibus (Tab. II fig. 41); dum dein circumcirca increseit, sensim magis

erigitur et fit fere cucullatim involuta, marginibus sursum hiantibus (l. c. fig. 42)". The celebrated author has not perceived that the leaf-like frond arises by splitting of a globular vesicle, but his fig. 41 seems to represent just the state where the split is formed. When the frond grows older, numerous rhizines are formed from the cells in the lowest part of the frond, which may result in the original basal cushion becoming less distinct; it is however always evident that the cells in the basal portion of the frond are situated in more than one plane.

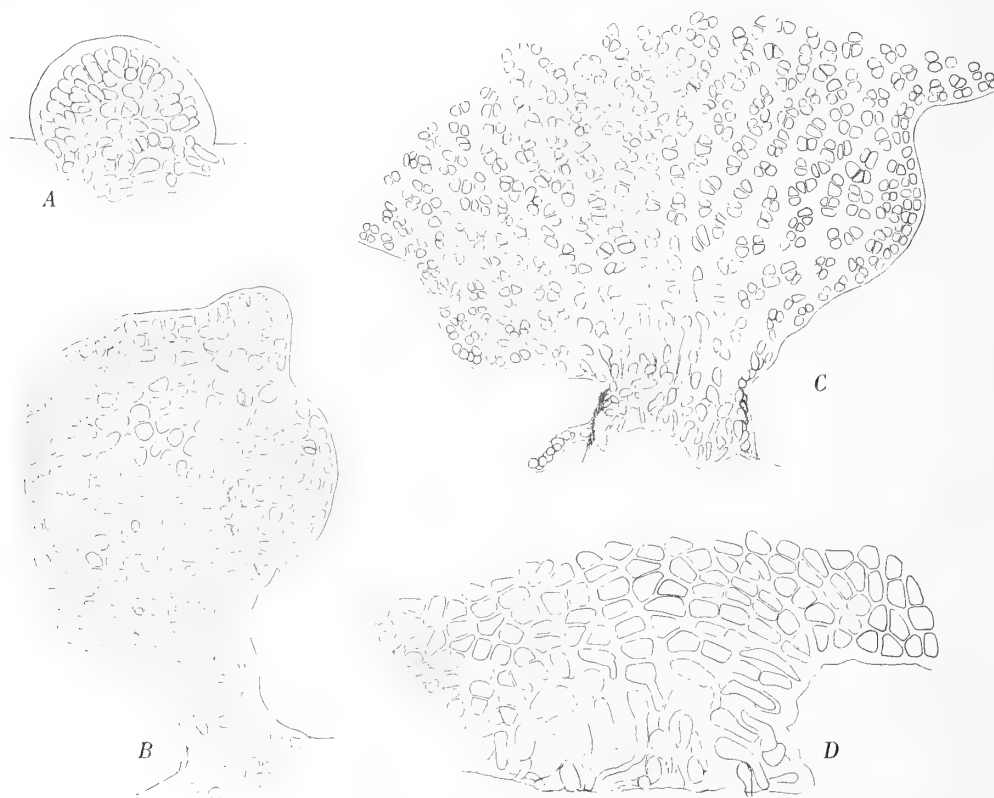


Fig. 9.

Porphyropsis coccinea. A, young plant, still hemispherical. 550:1. B, more developed plant with expanded lamina and spore-mother cells scattered over the frond. 340:1. C, lower part of older plant: it was not plane, but the borders were curved somewhat backwards. 340:1. D, basal portion of frond showing the rhizines. 550:1.

This plant offers an interesting analogy to the genus *Monostroma* among the *Chlorophyceae* and the genus *Omphalophyllum* among the *Phaeophyceae*. In *Porphyra naiadum* Anderson the frond also begins according to Hus (1902, p. 212) as a parenchymatous cushion, but the later development is quite different from the above described, the cushion producing from its surface hair-like projections which, dividing in two directions, give rise to a monostromatic frond.

The cell-divisions take place in some measure uniformly over the whole

monostromatic frond, more frequently however at the border, where the cells are therefore a little smaller and closer together. The intensive marginal growth results in the margin becoming much undulated. In fig. 9 C, which was drawn after a dried specimen, the cells are seen to be arranged in groups of two or four or a little more, rather distant from each other.

As said above, the reproduction has hitherto been unknown in this species, and I have also searched in vain for any indication of a fructification in several fully developed specimens. In other cases, however, I succeeded in finding a formation of spores corresponding to that in *Erythrotrichia*; even in very small specimens it could be observed. Thus in fig. 9 B several cells are divided by an inclined curved wall into a roundish cell filled with protoplasmic contents, the spore-mother cell, and a crescent-shaped sterile cell. The spore-mother cells are scattered without order over the whole frond; even marginal cells may produce them (fig. 9 B, at the summit). In fig. 10 is shown a small fragment of another, larger plant where most of the cells have produced spores. As I have only examined the plant in preserved condition I cannot give any information of the behaviour of the sterile cell on the escape of the spore.

The described fructification along with the peculiar development of the frond justify the establishment of this plant as the representative of a new genus. On account of the resemblance in appearance to the genus *Porphyra* I have named it *Porphyropsis*; a diagnosis is given above.

Only found in the eastern Kattegat in 20 to 25,5 meters depth, epiphytic on various Algæ. The largest specimens, 5 mm. high, with much undulated margin, were met with at the end of July; young plants were collected in May and July.

Localities. Ke: Fladen, ZF, on stalks of *Laminaria digitata*, on *Dilsea edulis* and *Rhodymenia palmata* a. o.; Groves Flak, VZ, on *Desmarestia aculeata*; Lille Middelgrund, IK, on *Odonthalia dentata*.

Erythrocladia gen. nov.

Thallus horizontaliter expansus, e filis ramosis, aliis algis adfixis, radiatim egredientibus, initio inter se discretis, dein in discum tenuem unistratosum confluentibus, constans. Crescentia florum apicalis. Sporangia eodem modo ac in genere *Erythrotrichia* in cellulis intercalaribus vel rarius terminalibus gignuntur. Generatio sexualis adhuc ignota¹.

¹ BATTERS has in 1896 (Journ. of Botany Vol. 34) established a genus *Colaconema*, characterized by branched filaments living in the cell-walls of various Algæ and by monosporangia "formed from portions either of the terminal cells of the principal axes, or of short swollen 1- or few-celled lateral branches, or even from a portion of a cell in the continuity of the filament. The undifferentiated portions of the cells forming cup-like bases for the sporangia". This genus was later placed by BATTERS (Journ. of Bot. Vol. 40, 1902, Supplement p. 57) near to the genus *Acrochaetium* (*Chantransia*) and one species was removed to this genus. The indicated mode of formation of the monosporangia suggests however that the genus may include forms belonging to the *Erythrotrichia*, and the sporangia arising



Fig. 10.
Porphyropsis coccinea.
Part of frond with sporangia. 630:1.

1. *Erythrocladia irregularis* sp. nov.

Thallus minutus, ambitu irregulari. Fila lateraliter ramosa, irregulariter radiantia, sæpe maxima pro parte inter se discreta. Rami plerumque in cellula subterminali nascuntur. Cellulæ plerumque oblongæ, long. 7—11 μ , lat. 3,5—5 μ , chromatophorum unicum parietale, ut videtur pyrenoide instructum, continentes. Sporangia diametro c. 4 μ .

SCHMITZ has established a genus *Erythropeltis* (1896 p. 313), which in its reproduction agrees with the genus *Erythrotrichia* but differs from it by the frond consisting only of a monostromatic disc with continuous border and with marginal growth. To this genus is only referred one species, *E. discigera* (Berth.) Schmitz¹, and to the same species BATTERS has later referred a new variety, var. *Flustræ*, (Journ. of Botany, Vol. 38, 1900 p. 376). The thallus is described in this as "orbicular, becoming confluent and irregular in outline", and it must therefore be supposed that the irregularity only appears by the fusion of originally separate discs. In our plant, on the contrary, the frond consists of mutually separate filaments which only at a later stage are partly confluent, and it must therefore be referred to a new genus.

The plant of which a diagnosis is given above was found in rather great numbers on some specimens of *Polysiphonia urceolata* dredged off Hirshals in the Skagerak. It forms irregular spots of up to 100 μ in diameter on the surface of the host-plant. It consists at first of branched filaments whose branches are mutually entirely separate. As shown in fig. 11 A the primary filament grows out in two opposite directions and gives off branches at both sides. These branches grow out and branch further, and in the more developed plant the filaments are therefore radiating in all directions in the horizontal plane, and the filaments are then more or less fused together in the central part of the frond. The filaments show apical growth, and transverse walls appear only in the terminal cells, a natural consequence of the filaments being fixed to the substratum. The branches usually arise in the subterminal cell, sometimes also in cells nearer the centre of the frond, but the terminal cell is only very seldom ramified. The ramification is thus strongly monopodial. Not seldom a number of consecutive cells each give off a branch, now alternating, now secund. The outline of the plant is always more or less irregular, some filaments growing longer than others.

The cells contain a single chromatophore, the form and structure of which I have not been able to determine with certainty, as I have only had dried specimens at my disposal. In several cases however it appeared to be undoubtedly parietal, and I often saw a body which I took to be a pyrenoid, though it was not very distinct (fig. 12).

from a cell in the continuity of the branched filaments recall the genus *Erythrocladia*, but the plants need further examination. None of the described species can apparently be referred to the genus *Erythrocladia*.

¹ The genus is founded on *Erythrotrichia discigera* Berth.; but, according to BERTHOLD (1882 p. 25), the disc in this species sometimes produces erect filaments, and it must therefore be supposed that SCHMITZ has taken the species in a more restricted sense than BERTHOLD.

The sporangia are cut off in the ordinary vegetative cells, in a similar manner as in the genus *Erythrotrichia*, by a more or less oblique curved wall. The formation of sporangia takes place usually in the inner, intercalary cells, more rarely in the terminal cells. The orientation of the wall is not always the same; usually the sporangium is cut out at the proximal end of the cell, apparently very seldom at the distal end; but the wall is not seldom longitudinal, particularly in short cells from which a branch is given off (fig. 12). The spores are in the fully developed state nearly globular, about 4μ in diameter; they have more granular contents than the vegetative cells and often show a distinct parietal chromatophore (fig. 11 C, D, fig. 12).

It is evident that

the above described plant cannot be referred to the genus *Erythropeltis* on account of the structure of the frond. It differs further from *E. discigera* var. *Flustræ* Batters by its much smaller spores, while the spores in BATTERS' plant are about 9μ in diameter.

Localities. Sk: Møllegrund off Hirshals, 11,5 to 15 meters, on *Polysiphonia urceolata*, August.

2. *Erythrocladia subintegra* sp. nov.

Thallus minutus suborbicularis. Fila sat regulariter radiantia, plerumque fere ad apices lateralliter connata, cellulis terminalibus tamen inter se plus minus discretis. Ramificatio fit in cellulis terminalibus, sæpe dichotoma. Cellulæ plerumque cylindricæ, lat. $3-4(-5)\mu$, long. $8-10,5\mu$. Sporangia in parte proximali aut distali cellularum orta diametro c. $4(-5)\mu$.



Fig. 12.

Erythrocladia irregularis. Plant with sporangia seen from above. 730:1.

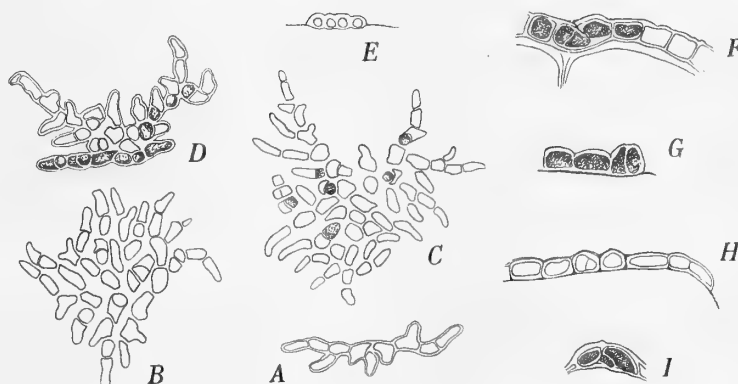


Fig. 11.

Erythrocladia irregularis. A, young plant seen from above. B—D, more developed plants with sporangia seen from above. E—I, plants in vertical section, F—I, with sporangia. A—E 390:1. F—I 620:1.

In company with the foregoing species I found some individuals of a species evidently nearly related to it, but showing however such differences that I think it best to consider it as a distinct species. It is more regular, more or less approaching to the orbicular form, and consists of more regularly radiating, closer together and a little thinner threads ($3-4\mu$), which are most often united almost to

the extremity, the terminal cells, however, being usually more or less free, and the same being also sometimes the case with the cell next to the end-cell. The ramification takes place exclusively or principally in the end-cells, and it has usually the character of a dichotomy, the cell bifurcating with two equally developed branches; the one branch, however, may sometimes be stronger than the other. The cell-walls of the filaments are thin and often not easily distinguishable. In the inner part of the cell-disc a granular substance is often to be seen in the middle of the

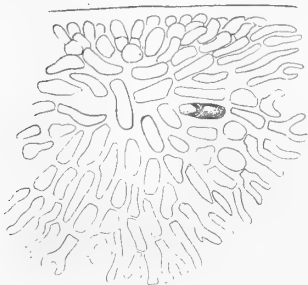


Fig. 13.

Erythrocladia subintegra. Frond growing on the rounded surface of *Polysiphonia urceolata*. In one cell a sporangium is cut off. 660:1.

walls; perhaps interstices between the filaments. The chromatophore seems to be of the same shape as in the foregoing species, it is parietal, apparently mantle-shaped, and seems to contain a pyrenoid; at all events a body of greater density is often visible in the middle of the cell. The cells are cylindrical or oblong or more irregular, usually 2—3 times as long as broad, in the inner part of the frond generally a little broader than at the margin.

The sporangia are, as in *E. irregularis*, cut off in the ordinary cells through a faintly curved wall, sometimes at the proximal, sometimes at the distal end of the cell; they have a parietal, cupshaped chromatophore and measure $4\ \mu$ in diameter.

This species shows more resemblance than the preceding to the genus *Erythropeltis*, from which it differs, however, by the margin of the frond consisting of separate filaments. If we supposed, that the distinction established between these two genera might prove not to be constant, there would be reason to compare *Erythrocladia subintegra* with *Erythropeltis discigera* Schmitz. Such a comparison, however, is difficult to undertake, as the last-named species is imperfectly known, in particular on account of what is alluded to above (p. 72) with regard to the limitation of the species. Using the magnification indicated by BERTHOLD I have calculated that the cells of his species are 5.5 to $7\ \mu$ broad, thus considerably broader than in *E. subintegra*, and in *Erythropeltis discigera* var. *Flustræ* Batt., where the spores are much larger than in our species, namely $9\ \mu$ in diameter; the cells are also larger than in *E. subintegra*. It must therefore be supposed, that the species described here has not hitherto been observed, but I admit that it needs further investigation as well as the species of *Erythropeltis* and the relation between this genus and the genus *Erythrocladia*, and the relation between the genera *Erythropeltis* and *Erythrotrichia*.

The description given above refers only to the specimens mentioned as found



Fig. 14.

Erythrocladia subintegra. Frond seen from above. A few sporangia are visible. 630:1.

on *Polysiphonia urceolata*. Later I have found, on *Flustra foliacea*, some discs which I think must be referred to the same species; they differed in their slightly larger dimensions and in the margin being partly continuous, the filaments being united to the extremities. These discs were thus still more similar to *Erythropellis*, but the filaments had always partly free endings. The filaments were 3,5—5 μ thick, narrowest at the border, broadest in the middle of the frond. The spores were 4—5 μ in diameter.

Localities, Sk: Off Hirshals (XO and YK), 11,5 to 15 meters, August.

Goniotrichum Kütz.

1. *Goniotrichum elegans* (Chauv.) Le Jolis.

Le Jolis, Alg. mar. Cherb. p. 103; J. Agardh (1883) p. 13; Berthold (1882) p. 26; Hauck, Meeresalg. p. 518. *Bangia elegans* Chauvin, Mém. Soc. Linn. Norm. t. 6 (not seen); Rech. sur l'org. d. plus. genr. d'Algues, Caen 1842 p. 33; Harvey Phyc. Brit. pl. 246.

Ceramium ceramicola Fl. Dan. tab. 2207 fig. 2 (? not the description).

This plant attains a length of at least 5 mm. in the Danish waters. The filaments are below up to 50 μ thick, above they become gradually thinner and are at the summit only 15 μ thick. The increase in thickness below is usually due only to the thickening of the gelatinous outer wall, the diameter of the cells not increasing, and the cells forming usually a single row. There may be, however, more than one cell at the same level. This was caused, in the cases examined by me, not by longitudinal division of the cells but by displacement of the cells, so that the growing axes became inclined, the cells dividing then as usually by walls perpendicular to the growing axis and becoming arranged in two irregular longitudinal rows, or even more than two cells may occur at the same level (fig. 15 E). The outer wall is usually uniform, limited outwards by a fine line. Sometimes, however, the cells are provided with a denser, special membrane. In the plant represented in fig. 15 E a rather thick, dense cuticular-like outer-wall was visible in the lower part of the plant; the cells were here also provided with dense special membranes, and between these and the outer membrane a stratification was often visible.

The ramification takes place in a manner reminding one of the so-called false branching of the *Scytonemataceæ*. The branches rise at a great distance from the end of the filament, a cell growing outward through the gelatinous wall, dividing by a wall perpendicular to the new direction of growth (fig. 15 B, C). The further growth results in the branch coming to form a direct continuation of the principal filament and often takes nearly the same direction as this, the upper part of the principal filament being more or less pushed aside and taking the appearance of a branch (fig. 16). The cell lying at the origin of the branches is divided by a transverse wall as well as all the other cells. New branches very often arise below the older; even in old filaments new branches may arise (fig. 15 A).

The cells are of rather variable length, usually about as long as broad or somewhat longer, up to 3 times as long, in the last case usually barrel-shaped. On the other hand they may be sometimes much shorter than broad, up to 3 to 4 times as broad as long (fig. 15 *B*); they are then proportionally broad, 9—12,5 μ , being otherwise 6,5—10 μ broad. The cells contain, as is well known, a star-shaped chromatophore with a central pyrenoid. The colour is lilac; in very light localities, however, it is faded, feebly yellowish or grayish. Such a pale yellowish specimen was placed in a glass-vessel filled with sea-water in a room with subdued light for some days. After 24 hours the colour was already somewhat reddish, and after

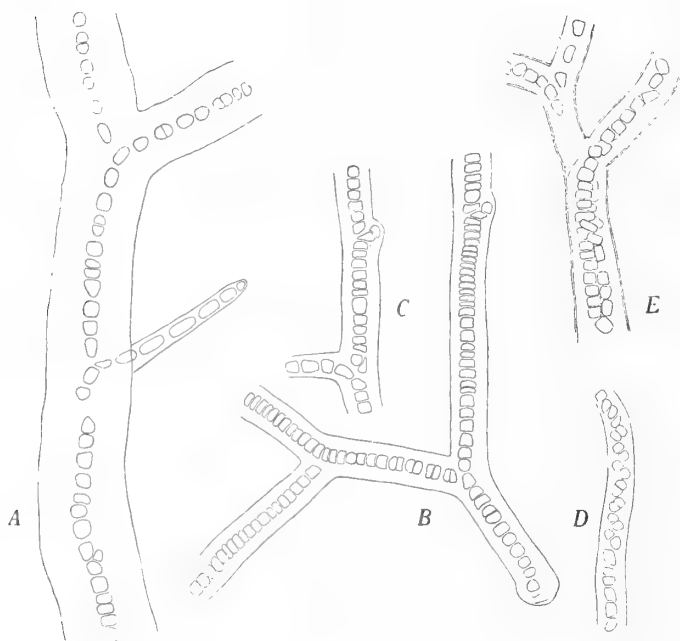


Fig. 15.

Goniotrichum elegans. *A*, portion of the older part of a frond with young branch below the older. — *B* and *C* show the normal ramification; the cells partly very short. — *D* and *E*, the cells displaced, giving up the uniserial arrangement; the cuticle in *E* very thick. — *B* and *C* from the Skagerak, the others from Sallingsund. — All figures 190:1.

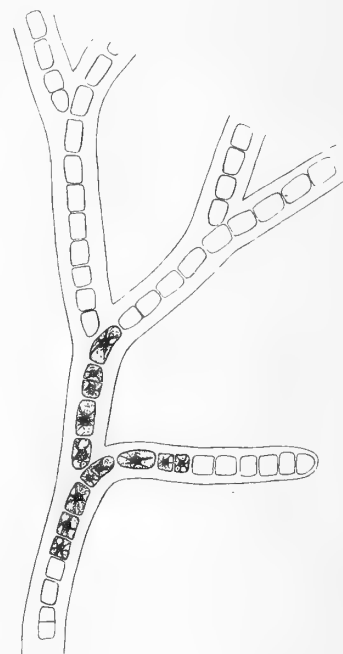


Fig. 16.

Goniotrichum elegans. After a living plant from Sallingsund. 290:1.

3 days the plant had a decided lilac colour. When dying the cells assume a light blue-green colour.

Concerning the reproduction I have made no observations. According to SCHMITZ (1894 p. 718 (14) and 1896 p. 314), monospores are produced by the ordinary cells, the cell-content being condensed and liberated as a naked spore. I have not seen this spore-formation, but I have sometimes remarked, that single cells were wanting in the filaments, probably because they had been set free in the form of spores.

The species has hitherto been found in the Skagerak, Limfjord and Kattegat,

but it is not improbable that it may have a somewhat larger distribution. The plant represented in Flora Danica tab. 2207 fig. 2, which is said to have been found by LYNGBYE in Odense Fjord, seems to judge from the figure to belong to this species; the description, however, belongs not to it but to *Erythrotrichia carnea*. In LYNGBYE's herbarium I have, from the locality in question, seen only the last-named species, not *Goniotrichum*, and it must therefore remain doubtful, if *Goniotrichum elegans* really occurs in Odense Fjord. — It has been found growing on various species of *Polysiphonia*, on *Rhodomela*, *Gloiosiphonia*, *Zostera* and *Flustra foliacea* in depths of 2 to 15 meters; it has only been observed in summer (June to August).

Localities. **Sk**: YK, N.W. of Hirshals, 15 m. — **Lf**: MH in Thisted Bredning; at several places in Sallingsund; LS, N. of Nykøbing. — **Kn**: Busserev at Frederikshavn; VT, N. of Læsø. — **Km**: BL, 9,5 m. — **Sa**: (Odense Fjord, Lyngbye?).

Asterocytis Gobi.

1. *Asterocytis ramosa* (Thwaites) Gobi.

C. Gobi in Arbeiten St. Petersb. Naturf. Gesellsch. Bd. X 1877 p. 85; Fr. Schmitz 1894 p. 717; id. 1896 p. 314; N. Wille, Algolog. Notizen, I—IV. Nyt Mag. f. Naturvid. Bd. 38, 1900 p. 7 Taf. I fig. 8—14.

Hormospora ramosa Thwaites in Harv. Phyc. Brit. pl. 213.

Goniotrichum ramosum Hauck, Meeresalg. p. 517, Batters, Mar. Alg. Berw. p. 13; Lakowitz, Algenfl. Danziger Bucht 1907 p. 79.

Goniotrichum simplex Lakowitz l. c. p. 80.

The genus *Asterocytis* has been established by Gobi in his "Bericht über die im Sommer 1877 ausgeführte algologische Excursion" published in 1879 in "Arb. St. Petersb. Nat. Ges." Bd. X. As this report has only been published in the Russian language, I give in the note below a translation in German of that part of the report which treats of this genus, and which Professor Gobi has kindly communicated to me¹. Later the genus and the species on which it was founded, *A. ramosa* (Thwaites) Gobi, has been mentioned by SCHMITZ (1894) who examined specimens of it from water of very low salinity at Greifswald and found that it had nearly the same mode of reproduction as the genus *Goniotrichum*, only with this difference that the monospores in the last-named are set free by the sporangial wall becoming mucilaginous, while in *Asterocytis* they escape through an opening in the

¹ "Die sogenannte *Hormospora ramosa* Thwaites (Vid. Harvey, Phyc. Brit. Tab. 213; auch Rabenhorst Fl. Eur. Alg. etc. Bd. III, p. 49) welche bis jetzt (als Pseudoparasit) nur an den Küsten Englands im Meerwasser angetroffen wurde, habe ich schon mehrere Male auf meinen früheren Excursionen im Finnischen Meerbusen (1872 u. 1873) gefunden und zwar auch immer nur auf anderen Meeresalgen aufsitzend in Form einzelner einfacher oder schwach verzweigter Fäden. — THWAITES, welcher zuerst diese Form beschrieb, (die im lebenden Zustande bis jetzt nur von SMITH beobachtet wurde), sah sie als zur Gattung *Hormospora* Brébisson gehörend an, mit welcher Gattung jedoch sie nichts Gemeinschaftliches hat sowohl in structureller Hinsicht, als auch in der Färbung ihres Zellinhaltes. Meiner Ansicht nach muss diese Alge als eine neue Gattung angesehen werden, für die ich provisorisch den Namen *Asterocytis* (strahlende Zelle) vorschlage, mit dem einzigen bis jetzt bekannten Repräsentanten *Asterocytis ramosa* (Thwaites) mihi." (l. c. p. 85—86).

unaltered sporangial membrane. In the treatise on the *Bangiaceæ* by the same author (1896), however, these characters are not mentioned; the author states only some less essential differences and declares that at least *A. ramosa* might possibly be referred to the genus *Goniotrichum*. In 1900 WILLE has given a more detailed description of an Alga which he had found at Mandal on the South coast of Norway, and which he refers to the same species. He gives a description of the setting free of the spores which is in accordance with that of SCHMITZ in 1894, but apparently without knowing the treatise of SCHMITZ, and he recommends that the genus *Asterocytis* should be kept distinct from *Goniotrichum*, primarily on account of the blue-green colour, but also because the author supposes that it produces resting cells, akinetes. It seems further that we may add as a distinctive character,

that *Asterocytis ramosa* grows in brackish water, as stated by several authors (HARVEY, HAUCK, SCHMITZ, BATTERS), while *Goniotrichum elegans* needs water of higher salinity.

I have found in several localities in the inner Danish waters a small Alga with blue-green cells, undoubtedly belonging to this species. It occurred, however, as a rule in small individuals, most frequently even unbranched, and in such cases agreeing with *Goniotrichum simplex* Lakowitz. Some of these specimens were short and only 9–11 μ thick, with vegetative cells 3–6 μ broad. Others were longer and somewhat thicker below, and the most vigorous provided with one or a few branches. Such specimens had often a thickness of 16 μ

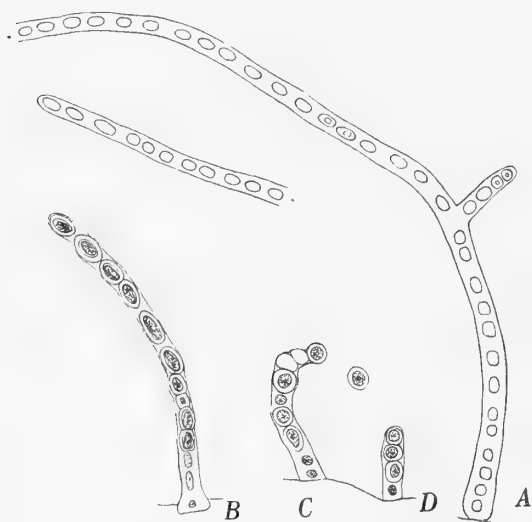


Fig. 17.

Asterocytis ramosa (from Guldborgsund). A, filament with branch; in some cells the pyrenoid is shown. B–D, small unbranched filaments with akinetes. 220:1.

near the base, in a single case of 25 μ ; the vegetative cells were about of the same size as in the smaller specimens, or they might be up to 7.5 μ broad. In the plants examined by WILLE the cells were, to judge from his figures and the magnification indicated, not a little greater (8–11.5 μ broad), and the plants were as a whole more vigorously developed. In the Danish specimens the cells are usually oblong or ellipsoidal, often ca. 2 times as long as broad, sometimes shorter, nearly globular. The chromatophore, as is well known, is star-shaped with a distinct pyrenoid; this, however, is not always central in the cell, the chromatophore being often nearer to the one side of the cell (fig. 17 B).

The occurrence of akinetes supposed by WILLE I have been fortunate enough to confirm with certainty. In nearly all my gatherings of this species there was found a number of filaments, the cells of which were for the most part transformed

into spores, being provided with a thick firm wall, of a much denser consistency than the gelatinous wall of the vegetative filaments. The akinetes are only surrounded by a thin common membrane, much thinner than the wall of the vegetative cells, and it is thus beyond doubt that the walls of the akinetes have risen by transformation of the innermost layers of the original gelatinous wall, and these cells thus agree completely with the conception of akinetes by WILLE. In some cases the akinetes are close together, in others they are separated. They are partly ellipsoidal or oblong, partly globular, measuring 8,5 to 10,5 μ in transverse diameter, up to 15 μ in length. In fig. 17 C a free akinete is to be seen and two emptied cells which have contained an akinete. As shown in fig. 17 C and D, the formation of akinetes may take place in very small plants.

As mentioned above, I have no doubt but that the specimens from the Danish waters really belong to *Asterocylis ramosa*, though it seems that the species does not attain in these waters the same dimensions as e. g. on the Norwegian coasts. The frequently occurring unbranched individuals do not represent a distinct species but only a reduced form, f. *simplex* (Lak.).

The species has been found with certainty in some places in the Smaalund Waters and in the Baltic, but is probably widely distributed in brackish water. I have formerly noted it from Holbæk Fjord and from Kertinge Vig, but omitted to keep the specimens. It has been found in shallow water near land, fixed on *Poly-siphonia violacea* and *nigrescens* and *Ceramium*, only in summer (July to September).

Localities. Ks: (Holbæk Fjord). — Sb: Kertinge Vig by Kerteminde. — Sm: Kragevig; off Petersværft; Guldborgsund, near Vennerslund. — Bb: Rønne, the reef S. of the town.

B. Florideæ.

II. Nemalionales.

J. AGARDH, Species genera et ordines Algarum, Vol. II, pars II, Lundæ 1851—52; Vol. III, 1876.

É. BORNET, Deux Chantresia corymbifera Thuret. Acrochaetium et Chantresia. Bull. soc. bot. France, tome LI, Sess. extr. 1904 p. XIV—XXIII, pl. I.

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—, Notes algologiques. Fasc. I. Paris 1876.

F. BØRGESSEN, Marine Algæ. Botany of the Færøes. Part II. Copenhagen 1902.

F. S. COLLINS, Acrochaetium and Chantresia in North America. Rhodora, Oct. 1906.

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H. KYLIN, Zur Kenntnis einiger schwedischer Chantresia-Arten. Botaniska Studier tillägnade F. R. Kjellman. Uppsala 1906 p. 113—126.

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G. MURRAY and ETHEL S. BARTON, On the Structure and Systematic Position of Chantresia. Journ. Linn. Soc. Vol. 28. 1891.

C. NÄGELI, Beiträge zur Morphologie und Systematik der Ceramiaceae. Sitzungsber. d. Akad. d. Wiss. München 1861. p. 401—415.

- F. OLTMANN, Morphologie und Biologie der Algen. I, Jena 1904, II 1905.
 F. SCHMITZ und P. HAUPTFLEISCH, Helminthocladiaceæ. Engler u. Prantl, Natürl. Pflanzenfam. I, 2, 1896 p. 327.
 F. SCHMITZ, Untersuchungen über die Befruchtung der Florideen. Sitzungsber. d. Akad. Wiss. Berlin 1883.
 G. THURET in LE JOLIS, Liste des Algues marines de Cherbourg. Cherbourg 1864, p. 104.

Fam. Helminthocladiaceæ.

Tribe Chantransiæ.

Chantransia (D. C.).

As shown by THURET (1864 p. 104), ELIAS FRIES was the first to define the genus *Chantransia* in such a manner that it had a natural limitation, and one could clearly see what plants it comprised. It was better characterized in 1864 by THURET who emphasized the fact that it has no tetrasporangia but only monosporangia. He mentioned at the same time the antheridia of *Ch. corymbifera*, and in 1876 (Notes alg. I p. 16) he described in conjunction with BORNET the sexual reproduction in this species, and the genus came thus to comprise species with and without sexual reproduction (comp. MURRAY and BARTON (1891)). In 1904, however, BORNET has proposed to separate the species with sexual reproduction from those bearing only sporangia, the first being kept in the genus *Chantransia*, while the others are referred to the genus *Acrochaetium* Nægeli (1861), which might otherwise be regarded as synonymous with *Chantransia*. I do not make this distinction in what follows, as I have arrived at the view that it would not lead to a natural classification of the species. In several cases there is great resemblance and probably also relationship between species with and without sexual reproduction, as e. g. between *Chantransia hallandica* and *baltica*, *Ch. efflorescens* and *Ch. pectinata*, *Ch. Thuretii* and *Ch. Daviesii*, and on the other hand the sexual species are mutually very different. That is also evident from BORNET's paper (1904) in which the species are divided after the differences in the basal portion of the frond, while in every group distinction is made between the asexual species, referred to *Acrochaetium*, and the sexual ones, referred to *Chantransia*. There is in reality no other difference whatever between the two genera than that of the presence or absence of sexual reproduction. It would, in my opinion, be equally justifiable to remove from other genera of Florideæ all the species in which only tetrasporangia are known. Undoubtedly, sexual organs will later be found in some of the species hitherto known as only asexual, as I have succeeded in detecting them in *Ch. hallandica*, where KYLIN had only described monosporangia, but on the other hand there is no doubt that many species are really devoid of sexual organs.

The great number of species described below will certainly appear surprising to many phycologists: it is the result of a careful search through a large material of Algæ. Many of them are very small and inconspicuous and need careful examination for determination. It is therefore not to be wondered at that they have been overlooked or perhaps so incompletely described that it is impossible to recognize them.

As two-thirds of the species described below are new, and as I have several new observations on most of the formerly described species, it might be useful to make here some general remarks on the genus *Chantransia*, based on the observations communicated below.

As shown by BORNET (1904), the structure and development of the basal portion of the frond within the genus *Chantransia* offers considerable differences which can be used in subdividing the genus. I fully agree with this excellent phycologist who by his small but important paper has largely contributed to the classification of this genus. If my classification does not always coincide with that of Dr. BORNET, it depends on the fact that I have not found representatives for all the subdivisions of Bornet in the Danish waters, and that I have found new species which do not fall under these groups. I may now give an account of the types found by me.

In some species the germinating spore is a globular or hemispherical basal cell which keeps its form and divides only on branching. This cell is fastened to the substratum by a cementing substance staining intensely blue by MAYER's Hæmalum¹. In some cases it gives off only free filaments (first group), in others it also produces endophytic filaments from its under side (BORNET's second group, of which no representative is mentioned below). In *Ch. efflorescens* (fig. 61) and *Ch. Thuretii* (figs. 30, 31) the hemispherical basal cell gives off an erect filament and several radiating, creeping, epiphytic filaments which later unite to a pseudoparenchymatous disc giving off a number of erect filaments. During this development the original basal cell becomes indistinguishable amongst the other cells of the basal disc. I believe that the basal part of the frond probably develops in a similar manner in some other species, the germination of which has not been observed (*Ch. attenuata*, *stricta*, *Daviesii*). In a small group of species (*Ch. polyblasta* (fig. 43) and *Ch. humilis* (fig. 44)), to which may be added the partly endophytic species *Ch. Dumontiae* (fig. 52) and *Ch. cytophaga* (fig. 50), the germinating spore is divided before ramification by a vertical wall into two cells of equal size each growing out in a creeping filament, which branches and forms a filamentous basal structure; in the central part of this the filaments may later fuse together, while a large number of relatively short erect filaments are given off from their upper side. In *Ch. virgatula* (incl. *secundata*) the germinating spore is usually divided by 3 excentric walls into 4 cells forming a parenchymatous disc, which for some time keeps this character during continued divisions of the cells, while later on some of the marginal cells may grow out into creeping filaments (figs. 37—41). In *Ch. leptonema* the development begins in the same manner, but the parenchymatous stage is very short, the disc at an early stage growing out into long creeping filaments (fig. 48). In *Ch. Macula* the basal disc behaves in a somewhat similar manner as in *Ch. virgatula*, but the erect filaments are much reduced or wanting, the sporangia being

¹ This substance attains an extraordinarily great development in *Ch. microscopica* var. *collopoda* Rosenv. (Deux. Mém. Alg. mar. Groenl., Medd. om Grøn. XX, 1898, p. 11), which, however, does not belong to *Ch. microscopica* Næg. but ought to be regarded as a distinct species, *Ch. collopoda* Rosenv.

situated directly on the basal disc or at the end of short unbranched erect filaments (fig. 42). An equally extreme reduction occurs in *Ch. reducta*, the frond of which consists of creeping filaments bearing sessile or short-stalked sporangia (fig. 49).

In certain species the thallus is partly endophytic. In *Ch. cytophaga* the development begins as in *Ch. polyblasta*, and it is only when the plant has become multicellular that some of the cells in the creeping filaments produce short filaments from their underside, which penetrate into the cells of the host plant (*Porphyra umbilicalis*), pushing aside the protoplasm and taking without doubt nutriment from it. This plant is thus a true parasite. The intracellular filaments or haustoria do not seem to penetrate from one cell into another but they may make their way again to the surface of the host plant (figs. 50, 51). In *Ch. Dumontiae* the development begins in the same way but the endophytic filaments are intercellular and become much longer (fig. 52). These intercellular filaments are still more developed in *Ch. Nemalionis*, where they form a widely extended system of branched threads, giving off free filaments at many points through the surface of the host (*Nemalion*), while creeping epiphytic filaments are wanting (figs. 53, 54). The germination has not been observed in this species. Finally, there is a group of species the filaments of which are entirely endophytic. *Ch. endozoica* Darb. forms a transition to this group, the (endozoic) filaments sending out through the surface of the *Alcyonidium* it inhabits numerous short slightly branched sporangia-bearing filaments. In *Ch. emergens* only the solitary short-stalked sporangia are free (fig. 55), and in *Ch. immersa* and *Ch. Polyidis* the solitary sporangia are even more or less sunk in the host plant (figs. 56, 58, 60)¹.

Most of the *Chantransia* are usually epiphytic and then not bound to particular host plants; several species also occur on Hydroids and Bryozoa, further on Mollusc-shells, *Ch. efflorescens* even on stones. Probably other species may also sometimes grow on stones but have not been detected there on account of their small size. On the other hand, the endophytic species appear to occur only in one particular species of Algæ, or several nearly related. Thus, *Ch. Dumontiae* has been found growing only in *Dumontia filiformis*, *Ch. cytophaga* only in *Porphyra umbilicalis*, *Ch. corymbifera* only in *Helminthocladia*, *Ch. Nemalionis* in *Nemalion lubricum* and *multifidum*, *Ch. immersa* in *Polysiphonia nigrescens* and *violacea* and in *Rhodomela subfusca*. The endozoic *Ch. endozoica* occurs only in *Alcyonidium gelatinosum*.

The form of the chromatophore is of great systematic value as pointed out by KYLIN (1906, p. 122). In the vast majority of Danish species the cells contain only one chromatophore, but these may again be divided into two groups. In a fairly large number of species the chromatophore has a central body lying in the

¹ *Rhodochorton Brebneri* Batters (Journ. of Botany 1897 p. 437 and 1900 Tab. 414 fig. 17), which is endophytic in *Gloiosiphonia capillaris*, is evidently a *Chantransia* belonging to this group, to judge from the mode of growth, the hairs and the chromatophore; its name must therefore be *Chantransia Brebneri* (Batt.) Rosenv. The genus *Colaconema* Batters (see page 71 note) seems also to comprise species referable to the group of the endophytic *Chantransia*.

axis of the cell, usually in its upper part, and giving off a number of lobes in several directions towards the periphery of the cell. These lobes proceed further along the periphery of the cell and may together form a more or less interrupted cylindrical parietal layer. In the middle of the central body lies a pyrenoid, which is thus situated in the axis of the cell. This form of chromatophore shows a particularly fine development in *Ch. immersa*, where the lobes are very long and distinct (fig. 57); but it must be confessed that in this species the pyrenoid is not always central (fig. 57 B, C). In two species, *Ch. Dumontiae* (fig. 52) and *Ch. cytophaga* (fig. 50), which also have stellate chromatophores, I have not been able to see any pyrenoid and must therefore suppose that it is wanting. In other species the chromatophore is an entire or somewhat lobed parietal plate containing a pyrenoid which is thus excentric in the cell. The pyrenoid is always prominent in the interior of the cell, and it is sometimes so large that it reaches almost to the opposite part of the chromatophore; when seen in profile, however, it is always easy to determine that it is parietal (figs. 30, 34, 54). Only in some species with very thin filaments it may be difficult to decide if the pyrenoid is axile or parietal, and transitions may perhaps occur. In *Ch. Polyidis* the chromatophore has a very peculiar structure, which I have unfortunately not been able to fully elucidate; it seems to be single but becoming very much branched (fig. 60). A third (or fourth) type of chromatophore occurs in *Ch. efflorescens* and *pectinata*, where each cell contains usually more than one spiral-shaped or more irregular band-like chromatophores (figs. 64, 66). — In pyrenoids of *Ch. immersa* treated with picric acid an angular body, probably a crystalloid, was observed (fig. 57).

The cells always contain a single nucleus lying almost in the central part of the cell, thus at a lower level than the pyrenoid. In some cases it is easily visible, even in the living state (fig. 30 C), in other it is concealed by the chromatophore; in *Ch. immersa* it is even sometimes found in a hollow in the mass of the chromatophore (fig. 57).

In nearly all the species hyaline, unicellular hairs occur at the ends of the filaments, which, when the filaments develop farther, are pushed aside, while the filament continues its way in the same direction as before, but really sympodially. This development has been pointed out by KYLIN (1906 and 1907) in some species, and I have found the same in all the species with hyaline hairs examined by me. The hair arises as the terminal cell of the filament, being however much narrower than the usual cells and containing no chromatophore but protoplasm and a nucleus. In the out-growing hair the protoplasm is collected towards the upper end of the cell and decreases in bulk on the lengthening of the hair. In some cases, however, e. gr. *Ch. rhipidandra*, the hair is not pushed aside but retains its terminal position, and the filament then makes a bend for each hair it produces, with the result that the sympodial nature of the filament becomes very evident (figs. 20, 21). But even in the cases where the hair is early shed, this process often causes a more or less pronounced obliquity of the upper end of the cell (fig. 18). The

duration of the hairs is very different in the different species; thus they are vigorous and very persistent in *Ch. virgatula*, while in other species they only appear in the young plants or parts of the plant but soon fall off. They occur in the endophytic *Ch. immersa* (fig. 57) and *Ch. Polyidis* (fig. 60 B), while they are wanting in the equally endophytic *Ch. emergens* (fig. 55). The hairs appear very early in the young plants; it may even happen that the germinating spore produces a hair before giving off any other organ (*Ch. gynandra*). In *Ch. Thuretii* the above-mentioned hairs seem to be wanting, but on the other hand the branches often taper into hair-like threads, the cells of which become long and discoloured and finally die, as in the hair-like organs of the Phæophyceæ (fig. 32 B). Similar hair-like organs occur in *Ch. Daviesii* (fig. 34 C).

Sexual organs have been observed in 5 of the species mentioned below. Four of these are monoecious, *Ch. rhipidandra* only is dioecious.

The carpogonium has nearly the same form in all species, being bottle-shaped with a trichogyne of about the same length as the ventral part. It is never borne at the end of a special carpogonic branch as in most other Florideæ even the Nemalieæ. In *Ch. gynandra* (fig. 18) and *rhipidandra* (fig. 20) the carpogonia are sessile and lateral on the main filaments. In the other species they are situated, usually laterally, on branched or unbranched branchlets, bearing often also antheridia or even sporangia (*Ch. hallandica*, figs. 21 A, E, 22 B; *Ch. Thuretii*, figs. 30, 31). In *Ch. efflorescens* their position is very remarkable, intercalary carpogonia very often occurring besides others which are lateral (fig. 62). In such cases the lowest cell in the short fertile branchlet develops into a carpogonium, sending out at its upper end a trichogyne upwards along the cell situated above the carpogonium. When the branchlet is two-celled, the upper cell is usually sterile and bears antheridia, but it may happen, though rarely, that two carpogonia are situated the one above the other (fig. 62 B). Intercalary carpogonia were hitherto unknown among the Florideæ; they were, however, also found in the here described *Ch. gynandra* where an antheridium is very often seated on the top of the carpogonium (fig. 18 H—K).

The antheridia¹ are small roundish cells usually placed two or more together on the fertile branchlets. Only in extremely dwarfish plants of *Ch. gynandra* and *Ch. hallandica* they were found sitting directly on the main filaments, which consist indeed of only very few cells (figs. 18 D, 24 C). In the monoecious species antheridia usually occur in the neighbourhood of the carpogonia, often very near, and in *Ch. gynandra* an antheridium is often, as already mentioned, placed directly on the carpogonium.

After fertilization the ventral part of the carpogonium grows out and divides by a transverse wall, the trichogyne being pushed aside and later thrown off, and

¹ The mother-cells of the spermatia, the spermatangia of SCHMITZ, may here in agreement with OLTMANN (1904 p. 669) be named antheridia. Quite recently N. SVEDELIUS has entered a plea for the term spermatangium (*Bau und Entwicklung der Florideengattung Martensia*. K. Svenska Vetenskapsakad. Handlingar. Band 43 No. 7. Uppsala 1908).

after further transverse divisions it becomes a 3- to 5-celled filament giving rise to a number of branches. The trichogyne or a small remnant of it may often be seen some time afterwards on the convex side of the second cell in the main filament of the gonimoblast (figs. 18 C; 20 E, H; 62 E, F, H). Unfortunately, I have not been able to follow the development of the cystocarp in *Ch. hallandica*, where it seems to be somewhat different (figs. 21, 22). In four of the five sexual species mentioned the carpospores arise only in the terminal cells of the branched gonimoblast. In *Ch. gynandra*, *rhpidandra* and *Thuretii* the branches are numerous, the cystocarp capituliform; in *Ch. hallandica* the number of the branches and the carpospores is very low. *Ch. efflorescens* is also in this respect different from the other species, the carpospores arising not only in the terminal cell but also in one or two of the cells lying behind in the filaments of the cystocarp, thus seriatly (fig. 63).

Sporangia occur in all known species of *Chantransia*. For some time it was generally accepted that monosporangia only occur in this genus, the older statements of tetrasporangia by HARVEY being supposed to be due to some error. In later years, however, tetrasporangia have been pointed out with certainty in some species by SCHMITZ and HAUPTFLEISCH (1896), BØRGESSEN (1903) and KYLIN (1906 and 1907), and I have been able not only to confirm these statements but also to find tetrasporangia in five other species, so that the occurrence of tetrasporangia is now established in eight of the species mentioned below (*Ch. Thuretii*, *Daviesii*, *virgatula*, *polyblasta*, *cytophaga*, *Dumontiæ*, *efflorescens*, *pectinata*). In *Ch. Dumontiæ* and *polyblasta* tetrasporangia only have been met with, in the others also monosporangia. The division of the tetrasporangia is always cruciate, the first division being horizontal. Amoeboid movements of the monospores immediately after the liberation, similar to those described formerly for *Helminthora divaricata*, were observed in *Ch. Thuretii* (fig. 30).

In most of the species provided with sex-organs sporangia occur in the sexual plants, in the monoecious species as well as in the dioecious *Ch. rhpidandra*. On the other hand, as the sex-organs are not present in all the plants, individuals bearing only sporangia will always be met with. In *Ch. efflorescens* only there is a sharp distinction between sexual plants and sporangia-bearing plants. This is perhaps connected with the fact that tetrasporangia occur in this species. As shown by YAMANOUCHI¹ the tetrasporic plants of *Polysiphonia violacea* show double the number of chromosomes to that of the sexual plants, and a reduction in the number of chromosomes takes place by the formation of the tetraspores. If that is general for the Florideæ, a similar alternation of tetrasporic plants with sexual plants must be supposed to exist in *Ch. efflorescens*, and that is supported by the fact that the sporangia-bearing plants occur in the Danish waters chiefly in spring, the cystocarp-bearing plants in summer. In the sexual species with monosporangia such alternation of generations does not occur, and the reduction of chromosomes must be supposed to take place not in the sporangia but probably in the cystocarps, as in

¹ S. YAMANOUCHI, The life-history of *Polysiphonia violacea*. Botanical Gazette Vol. XLII. 1906.

*Nemalion*¹. Several questions connected with that just mentioned deserve a closer examination, thus, the cytological behaviour of the monosporangia of *Ch. efflorescens* in comparison with that of the tetrasporangia of the same species, further the nuclear division of the tetrasporangia in the non-sexual species.

The following classification of the species is based in particular on the characters of the basal part and of the chromatophore. *Ch. efflorescens*, however, which differs from the others in several characters, as mentioned above, is first separated as representing a particular sub-genus, *Grania*, named after the Norwegian investigator who first described its sex-organs, and to the same sub-genus is referred *Ch. pectinata*, with similar chromatophores and probably related to it.

Key to the Danish species of *Chantransia*.

- I. Subg. *Euchantransia*. One chromatophore, carpospores only in the last cell of the sporogenous filaments.
 1. Frond epiphytic.
 2. A single basal cell. Group I.
 3. With sex-organs.
 4. Antheridia situated on the carpogonia or on unicellular branchlets 1. *Ch. gynandra*.
 4. Antheridia never situated on the carpogonia.
 5. Antheridia singly or two together, cystocarps with few carpospores; monoecious 3. *Ch. hallandica*.
 5. Antheridia usually in flat triangular clusters, cystocarps nearly globular with numerous carpospores; dioecious 2. *Ch. rhipidandra*.
 3. Without sex-organs.
 4. Pyrenoid parietal 1. *Ch. gynandra*.
 4. Pyrenoid axile.
 5. Cells nearly cylindrical.
 6. Filaments 9—11 μ thick, spor. 14—15 \times 9—10 μ 2. *Ch. rhipidandra*.
 6. Filaments at most 7 μ thick.
 7. Filaments 5—6 μ thick, sporangia 10 \times 6—7 μ 3. *Ch. hallandica*.
 7. Filaments 6—7 μ thick, sporangia 12—16 \times 8—10 μ 4. *Ch. baltica*.
 5. Cells roundish, frequently barrel-shaped 5. *Ch. moniliformis*.
 2. Basal layer multicellular. Group II.
 3. Basal layer composed of filaments more or less fusing together into a pseudoparenchymatous disc.
 4. Erect filaments well developed; pyrenoid parietal.
 5. Erect filaments branched.
 6. Branches scattered; monospores, rarely tetraspores.

¹ Comp. J. J. WOLFE, Cytolog. Stud. on *Nemalion*, Ann. of Botany Vol. 18 Oct. 1904.

7. Sex-organs may occur; thickness of filaments usually less than $10\ \mu$, cells usually 5—8 diam. long, sporangia sessile or on unicellular branchlets on the inner side of the branches 6. *Ch. Thuretii*.
7. Without sex-organs; filaments 9— $12\ \mu$ thick, cells 2—4 diam. long; sporangia-bearing branchlets repeatedly branched, often in the axils 7. *Ch. Daviesii*.
6. Branches partly opposite 8. *Ch. attenuata*.
5. Erect filaments unbranched, bearing only numerous sporangia-bearing branchlets, nearly from the base to the top 9. *Ch. stricta*.
4. Erect filaments numerous, rather short (up to $300\ \mu$) to very short or wanting; pyrenoid axile.
5. Erect filaments up to ca. $300\ \mu$ long, branched.
6. Filaments 7— $10\ \mu$ thick, sporangia tetrasporous 12. *Ch. polyblasta*.
6. Filaments 3— $4\ \mu$ thick, sporangia monosporous 14. *Ch. leptanema*.
5. Erect filaments up to ca. $60\ \mu$ long, usually unbranched, sporangia monosporous.
6. The cells of the creeping filaments give off 2—3 erect filaments bearing terminal and lateral sporangia 13. *Ch. humilis*.
6. The cells of the creeping filaments bear one sessile or stalked sporangium 15. *Ch. reducta*.
3. Basal layer first a parenchymatous disc, later growing out into radiating filaments; pyrenoid axile (*Ch. leptanema*).
4. Erect filaments 1—2 mm. long 10. *Ch. virgatula*.
4. Erect filaments very short or wanting; sporangia sessile on the basal disc or terminal on the erect filaments... 11. *Ch. Macula*.
1. Frond partly or entirely endophytic or endozoic. Group III.
2. Vegetative part partly endophytic.
3. Epiphytic creeping filaments present.
4. Endophytic filaments intracellular 16. *Ch. cytophaga*.
4. Endophytic filaments intercellular 17. *Ch. Dumontiae*.
3. Epiphytic creeping filaments wanting 18. *Ch. Nematiosis*.
2. Vegetative part entirely endophytic or endozoic.
3. Vegetative filaments endozoic, giving off short free, sporangia-bearing filaments 19. *Ch. endozoica*.
3. Filaments entirely endophytic.
4. Filaments creeping in the outer cell-wall of *Polysiphonia*; sporangia entirely free, short-stalked, single 20. *Ch. emergens*.
4. Filaments intercellular; sporangia partly or entirely immersed in the host.

5. Chromatophore stellate..... 21. *Ch. immersa*.
 5. Chromatophore much divided 22. *Ch. Polyidis*.

II. Subg. *Grania*. Chromatophores ribbon-like, spiral-shaped, usually more than one; carpogonia often intercalary; carpospores seriate. Group IV.

1. Filaments usually 5—6 μ thick; free descending filaments usually present; sporangia tetrasporous or monosporous, on alternate or opposite branchlets; sex-organs present 23. *Ch. efflorescens*.
 1. Filaments near the base 6—9 μ (or thicker); free descending filaments usually wanting; sporangia or sporangia-bearing branchlets seriate on the inner side of the branches; sex-organs wanting 24. *Ch. pectinata*.

Subgenus Euchantransia.

Group I. Frond epiphytic with a single basal cell.

1. *Chantransia gynandra* sp. nov.

Thallus minutus. E cellula basali subglobosa, diametro 7,5—9 μ , egrediunt filia 2—4 simplicia, ad circ. 200 μ alta, e cellulis diametro plerumque 2—3-plo longioribus, crassitudine 5—6 μ , superne nonnunquam leniter (ad 7 μ) incrassatis, constantes. Ramuli nulli vel pauci, minuti, unicellulares. Chromatophorum parietale zonale, pyrenoide instructum, mediam partem cellulæ occupans. Pili hyalini terminales et laterales adsunt. Sporangia, antheridia et carpogonia in uno eodemque individuo occurrunt. Sporangia in filis lateralia sessilia solitaria vel in uno articulo duo approximata vel opposita, vel in ramulis terminalia monospora, ovata, long. 9,5—10 μ , lat. 5—6 μ . Carpogonia in filis lateralia. Antheridia ad apicem ramulorum solitaria vel sæpius gregaria vel carpogonio juxta trichogynum solitaria imposita, hemisphærica, oblique breviter ovata vel subconica, long. c. 2,5 μ . Cystocarpia capitula irregularia e filis radiantibus longitudine vario constantia, carposporis in cellulis ultimis, sporangiis similibus, formati.

This interesting species was found in abundance growing on some specimens of *Ectocarpus confervoides* dredged in the Northern Kattegat. The nearly globular basal-cell, which is fixed to the host by a very thin layer of a cementing substance, gives off a filament upward and usually two similar, though often shorter, filaments out to the sides. The filaments are either absolutely unbranched or bear, besides reproductive organs, only a few one-celled or rarely two-celled branchlets. The cells which are usually a little constricted at the transverse walls, contain a belt-shaped, rather narrow chromatophore containing a pyrenoid projecting inward. Hyaline hairs always occur; they are either terminal on the filaments and the branchlets or lateral. The hair situated at the top of the terminal cell is later pushed to the side, the terminal cell growing out beyond the insertion of the hair (fig. 18 K) which, after the next cell-division, comes to be situated at the upper end of the subterminal cell. Nearly all the lateral hairs have developed in this manner;

it seems however that really lateral hairs may also sometimes occur. At all events two hairs may be found on one cell (fig. 18 *G*). Most of the hairs are early thrown off, leaving however a vestige in the outline of the cell, this being a little enlarged at the upper end. I have once seen a hair given off from a basal cell which had not yet produced any filament.

Most of the plants bear at the same time sporangia and both kinds of sexual organs, some plants, however, bear only sexual organs. The sporangia are sessile on the sides of the filaments or sometimes borne by the unicellular branchlets (fig. 18 *A*); they open by a split at the top (fig. 18 *A*, *G*).

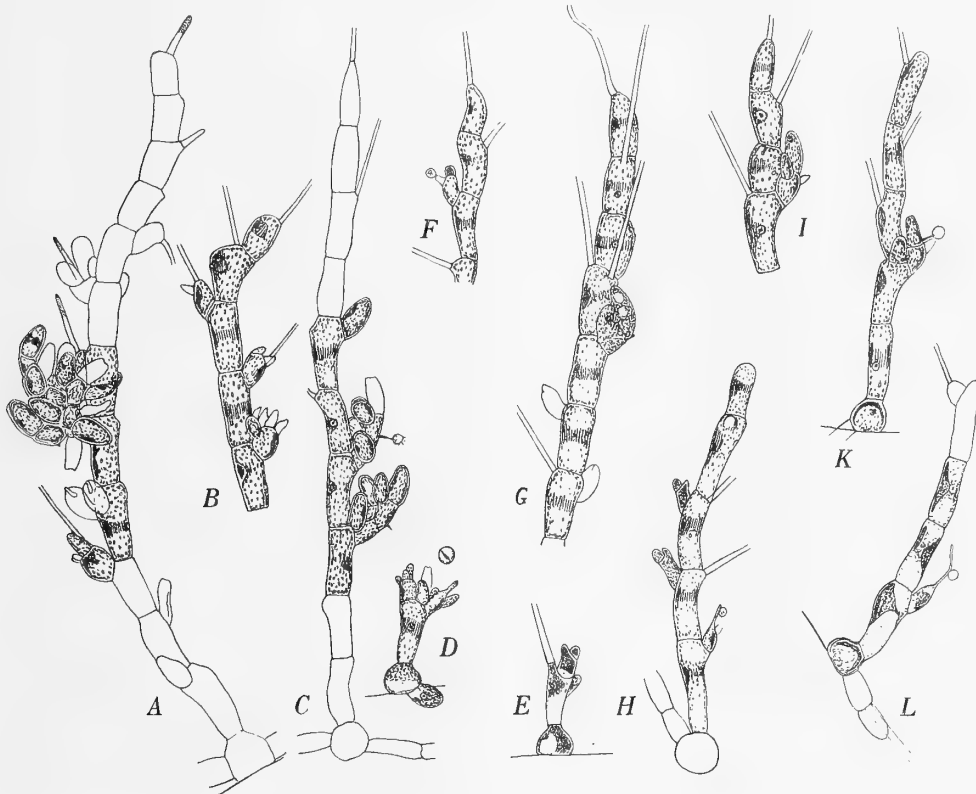


Fig. 18.

Chantransia gynandra. *A*, plant with 3 branchlets, a cystocarp and sporangia. *B*, upper end of filament with branchlets bearing antheridia. *C*, plant with two cystocarps and one sporangium. *D*, dwarfed plant with antheridia and one carpogonium; a spermatium is lying above. *E*, dwarfed plant (comp. text). *F*, two antheridia on a branchlet; a spermatium is situated immediately outside one of the antheridia. *G*, part of filament with a young cystocarp and two empty sporangia. *H*, plant with three carpogonia with epigynous antheridia, two young, the third in the fertilization stage. *I* and *K*, plants with young cystocarps and epigynous antheridia. *L*, plant with carpogonium in fertilization stage. 630:1.

The carpogonia are situated on the sides of the filaments at various distances from the base; they are bottle-shaped, the trichogyne being of almost the same length as the ventral part. The antheridia are situated either on the carpogonia or on the ramuli; in the first case they are always solitary, in the latter there are

usually two or more crowded together. Only in the dwarfed plant represented in fig. 18 *D* have I seen the antheridia situated directly on the filament, but in this case the filament was only two-celled. The juvenile stages of the epigynous antheridia show that these antheridia are really terminal, while the trichogyne rises as a lateral outgrowth from the subterminal carpogonium (fig. 18 *E, H*), a case hitherto unknown among the Florideæ. I have repeatedly, in material preserved in alcohol, observed a little globular body lying immediately outside an empty antheridium or at a slight distance from it (fig. 18 *F, D*); as it agreed in size with the spermatia adhering to the trichogynes (fig. *C, K, L*), I have no doubt that they were really spermatia. Probably a spermatium is often transferred from an epigynous antheridium to the trichogyne of the supporting carpogonium. After fertilization the ventral part of the carpogonium grows out into a slightly inwards curved filament which becomes 3-celled. The trichogyne is pushed outward so that it becomes situated on the convex side, on the second cell of the filament (fig. *C*). The two lowest cells give off several branches, while the uppermost cell produces a carpospore (fig. *C*). Possibly the primary filament of the gonimoblast may sometimes consist of more than three cells. The lateral branches obtain a different length, some becoming relatively long, articulated, curved and branched, others remaining short and in part apparently unicellular, producing a carpospore without division. The mother-cells of the carpospores have about the same form and size as the sporangia. The trichogyne or the lowest part of it can be seen long after fertilization on the second cell of the main filament; even in mature cystocarps a slight remnant of it is sometimes to be seen, (fig. *A*). The emptied epigynous antheridium is also often to be found some time after fertilization; it is then situated on the first cell of the main filament (fig. *I, K*).

While the plants often attain a length of 200 μ , very reduced plants also occur, consisting of very few cells (fig. *D, E*). In the plant shown in fig. *E* there was only developed one filament consisting of one cell only, bearing a hair, a carpogonium with epigynous antheridium and a lateral outgrowth the character of which could not be determined.

The species differs from all more exactly described species of this group through the position of the sexual organs, the form of the cystocarps and the belt-shaped chromatophore. It may have been observed earlier, however, and possibly some of the plants mentioned under the name of *Callithamnion minutissimum* have belonged to this species. ZANARDINI's species of this name (Synops. Alg. mar. Adr. 1841 p. 176; HAUCK, Oesterr. bot. Zeitschr. 1878 Taf. II fig. 7—8), however, belongs not to this group; and as to SUHR's species (KÜTZING Spec. alg. 1849 p. 640, Tab. phyc. XI tab. 57), it is impossible to identify it from the description and figures. On the other hand, the specimens referred to that species by CROUAN (Alg. mar. du Finistère No. 114, Florule du Finistère p. 134) show so much resemblance with the species here described, that they might probably be identical. This, however, cannot yet be decided with certainty as the specimens of CROUAN bear no sexual

organs (Comp. BORNET 1904 p. XIX). On the contrary, they bear abundant sporangia, in much greater number than in the Danish plants, very often two on each cell, 10—11 μ long, 6—7 μ broad, consequently nearly as in our plants, and of the same shape. The thickness of the filaments is the same (5,5—6 μ), the basal cell is ca. 10 μ in diameter and the chromatophore is parietal, and finally CROUAN's plant grows on an *Ectocarpus* like the Danish plant. All these agreements suggest that CROUAN's plants are asexual individuals of *Ch. gynandra*.

Locality. Kn: Tønneberg Banke, ZA, 12 to 18 meters, July.

2. *Chantransia rhipidandra* sp. nov.

E cellula basali globosa vel rarius leviter depressa, diametro c. 14 (13—15) μ , 2—3 fila erecta parce ramosa usque ad 350 μ saltem alta, egrediunt. Rami sparsi simplices vel parce ramosi. Cellulae (7,5—) 9—11 μ latae, diametro 2—3 (—4)-plo longiores, chromatophorum stelliforme, pyrenoide centrali, in parte superiore cellulae sito, instructum, continentes. Fila primaria ramique apice plerumque pilo hyalino instructi. Sporangia in filis lateralia sessilia aut stipitata, stipite unicellulari, sparsa vel (rarius) opposita, saepe seriata, monospora, ovata vel obovata, long. 14—18,5 μ , lat. 9—10 μ . Antheridia in ramulis, in una fere planitie ramosis, semiflabelliformibus terminalia, 6—6,5 μ longa, 4—5 μ crassa. Carpogonia in filis primariis vel in infima parte ramorum sessilia; cystocarpia subglobosa; carposporae in cellulis ultimis cystocarpii formatae, eadem fere forma et magnitudine ac monosporae. Antheridia et carpogonia in plantis distinctis, sporangia in plantis distinctis aut in plantis sexualibus.

This species is distinct from all well-defined species with one basal cell. Thus, it differs from *Ch. microscopica* (Nægeli) (1861, p. 407 figs. 24, 25) by its globular basal cell¹ being much broader than the filaments and giving off 2 or 3 filaments, and by having longer cells. From *Ch. hallandica* it differs by its larger proportions, the position of the antheridia and the form of the cystocarpia etc., from *Ch. microscopica* var. *pygmaea* KUCKUCK (Bemerk. Helg. II, p. 392 fig. 15) in the dimensions, the absence of endophytic filaments etc. *Ch. unilateralis* KJELLMAN (Algenfl. Jan Mayen, Arkiv f. Bot. Bd. 5 No. 14, 1906 p. 11) differs by having much thicker and more branched filaments and almost globular sporangia, and *Ch. Alariae* JÓNSSON (Mar. Alg. Iceland. Bot. Tidsskr. vol. 24 p. 132) differs also by having much thicker and more branched filaments, and further by the branches being often opposite; both these species are devoid of sexual organs. From the short description given of *Ch. microscopica* BATTERS (Journ. of Bot. 1896 p. 9) it appears that this species can scarcely be identified with our species, for according to BATTERS the antheridia form "very compact clusters at short intervals along the axes and branches", and

¹ NÆGELI mentions and figures in *Acrochaetium microscopicum* a basal disc, "von welcher es (nach Untersuchung an getrockneten Exemplaren) zweifelhaft bleibt, ob es eine niedergedrückte scheibenförmige Zelle oder nur Verdickung der Membran ist (Fig. 24, 25)". On examining the specimens of this species in RABENHORST'S Die Algen Europas No. 1650, I have found that this basal disc is a cementing substance, occurring in all the species of this section.

the cystocarpia are "clustered near the basal disc", and according to KUCKUCK (l. c.) the filaments are narrower ($4.5-7\mu$) in BATTERS' species than in *Ch. rhipidandra*.

To the description given above the following remarks may be added. The basal cell is fastened to the surface of the host plant by a very distinct disc consisting of a cementing substance staining intensely blue in MAYER's hæmalum. The sporangia are usually alternate or more or less regularly second (fig. 19 on the left), seriate, as the plant generally has a tendency to unilateral ramification. When each cell bears two sporangia, they are usually, but not always, opposite, and several pairs of sporangia are then often superposed (fig. 19 to the right).

When the sporangium is placed on a unicellular branchlet, this often bears also a hair; the hair being terminal, the sporangium is then lateral on the branchlet (fig. 19).

The antheridia are placed in characteristic, flat, usually triangular clusters consisting of 2- to 5-celled branchlets branched only on the upper side; they are produced in a number of one to three on all the terminal cells of the cluster, and also singly by some of the other cells (fig. 20 A, B).

The carpogonia are sessile on the upper part of the main filaments or on the lower part of the branches; they are bottle-shaped, with a trichogyne of about the same length as the ventral part (fig. 20 D, c). After fertilization the carpogonium grows out in a three-celled filament which still bears the trichogyne or a remnant of it on the second cell (fig. 20 E, H, t). A branch is now given off from the lowest cell, the primary filament is further divided so that it becomes 4- or 5-celled, and it gives off more branches from the lower cells. In fig. 20 F, the primary filament is seen to be 5-celled; the uppermost cell produces a carpospore, the others,



Fig. 19.
Chantransia rhipidandra. Two spore-bearing plants. 300:1.

with exception of the subterminal cell, each bear two branches which are either unicellular and produce directly a carpospore or become 2- or 3-celled and produce a carpospore in the end-cell. The ripe cystocarpium is of somewhat irregular, nearly globular shape; its peripheral cells are swollen and each produce a carpospore (fig. 20 D).

This species has only been found at Frederikshavn, where it was collected in August 1891 growing on *Porphyra umbilicalis* on the outer and the inner side of the moles. It grew on the flat side of the fronds, in some cases so abundantly that the frond of *Porphyra* had become dull and purplish.

Locality. Kn: Frederikshavn.

3. *Chantransia hallandica* Kylin.

H. Kylin (1906) p. 123.

Ch. parvula Kylin (1906) p. 124.

KYLIN in 1906 described two allied species, *Ch. hallandica* and *Ch. parvula*, differing from each other by the filaments being a little thinner, giving branches off at all sides and consisting of longer cells, further by the sporangia being often stalked and then usually placed two or three together in *Ch. hallandica*, while *Ch. parvula* is smaller, has shorter, a little thicker filaments with branches placed in one or two rows and usually sessile sporangia. In several places in the Danish waters I have met with *Chantransia* agreeing exactly with these two species, but I have also found specimens which were intermediate in regard to one or more of the characters mentioned. As I have also found sexual organs, besides the sporangia described by KYLIN, it will be necessary to mention these plants more closely.

In the plants corresponding to KYLIN's *Ch. hallandica*, the basal cell is (7.5—) 9—11 (—14) μ in diameter, thick-walled; it gives off usually

3, at the most 4 erect filaments, (4—) 5—6 μ thick and consisting of cells usually 3—4 (—5) times as long as broad. Hyaline hairs are usually present. The originally terminal hair is often pushed aside by the cell bearing it growing out sympodially in the same direction as before, and the hair leaves then only a faint mark at the upper end of the cell which has produced it; but in other cases the hair retains its terminal position, and the filament, i. e. the branch, grows out in another direction (fig. 21 E). Transitional cases are also found. The cells contain

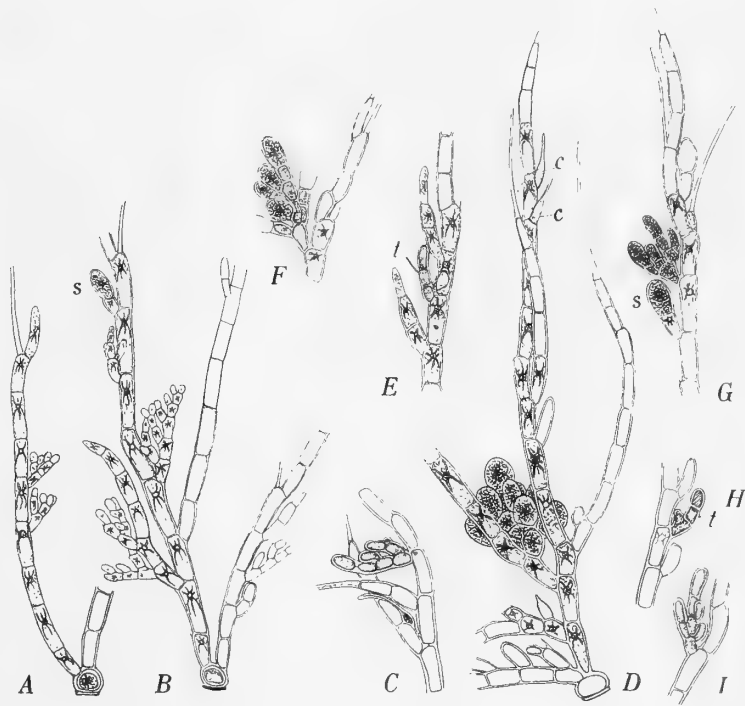


Fig. 20.

Chantransia rhipidandra. A and B male plants, B also with sporangia, s. — C—I portions of female plants. The carpogonia and the young cystocarps made more easily recognizable by shading; in C an unfertilized carpogonium and a young cystocarp; in D carpogonia, c, and a ripe cystocarp; in E a fertilized carpogonium, 3-celled, still with trichogyne, t; in F a nearly ripe cystocarp after having been subjected to pressure; in G an unripe cystocarp and two sporangia; in H a young cystocarp and an empty sporangium; in I a young cystocarp. 300:1.

a stellate chromatophore with central pyrenoid lying in the upper part of the cell, the strands radiating from the central body forming a more or less continuous peripheral layer. As KYLIN (1906 fig. 8 G) represents the pyrenoid as being sometimes lateral, it may be remarked that I have always found it central.

The sporangia are lateral on the filaments, sessile or stalked, i. e. situated on one-celled branchlets and then usually two on each stalk-cell. The branchlet may also be two-celled, the primary stalk-cell bearing, besides a terminal sporangium, a lateral stalk-cell with a sporangium. Usually only one sporangium or sporangium-bearing branchlet is situated on each cell in the filaments. The sporangia are ovate to oblong, (8,5 –) 9,5–10,5 (–13) μ long, (4–) 6–7 (–9) μ broad.

Many plants bear exclusively sporangia, but by searching, specimens bearing also or exclusively sex-organs are easily found, at all events in the Danish waters. In describing the sexual organs I refer also to the plants belonging to the var. *brevior*. The antheridia



Fig. 21.

Chantransia hallandia a. typical. A, with sexual organs and sporangia, 385:1. B, with sporangia, 385:1. C, with cystocarps, 300:1. D, fragment of plant bearing branchlets with antheridia and sporangia, 620:1. E, fragment of plant bearing a branchlet with carpogonium and antheridia, and an emptied sporangium, 620:1. A and C from ΔH^1 , B, D, E from LC.

are placed singly or in small groups of two or three at the end of shorter branches; they are round, $3\ \mu$ long, $2.5\ \mu$ broad. The carpogonia are situated on similar, rather short, usually 1- to 5-celled, branches as those bearing the antheridia, and they are often placed in the immediate vicinity of the antheridia (figs. 21 E, 22 B). I have not succeeded in following the development of the cystocarpia, especially the first stages. It seems that the trichogyne disappears very soon after fertilization. In fig. 21 E is shown a carpogonium immediately before fertilization, in fig. 23 another with adhering spermatia, and in fig. 22 A and C abortive carpogonia are shown, but I have never seen a trichogyne on a carpogonium after the commencement of the divisions; it might perhaps have been on the place marked with * in fig. 22 D; the two spores situated on each side of this must then be carpospores and the whole cell-complex a cystocarpium. A very similar case is shown in fig. 23 B, and the plant shown in fig. 21 C bears undoubtedly also two or three cystocarps. The cystocarps are thus corymbiform and produce only a very small number of carpospores. Usually only two carpospores are present at the same time, but it is probable that others may develop after the first have been exhausted. The carpospores are somewhat larger than the sporangia, viz. $14-18\ \mu$ long, $7-9\ \mu$ broad.

At some places, mostly in the northern Kattegat, specimens were met with which agreed in all essentials with those described above but differed in having shorter cells, about twice ($1\frac{1}{2}$ —3 times) as long as broad. The cells being, as in the main form, often a little enlarged at the upper end, they may differ somewhat

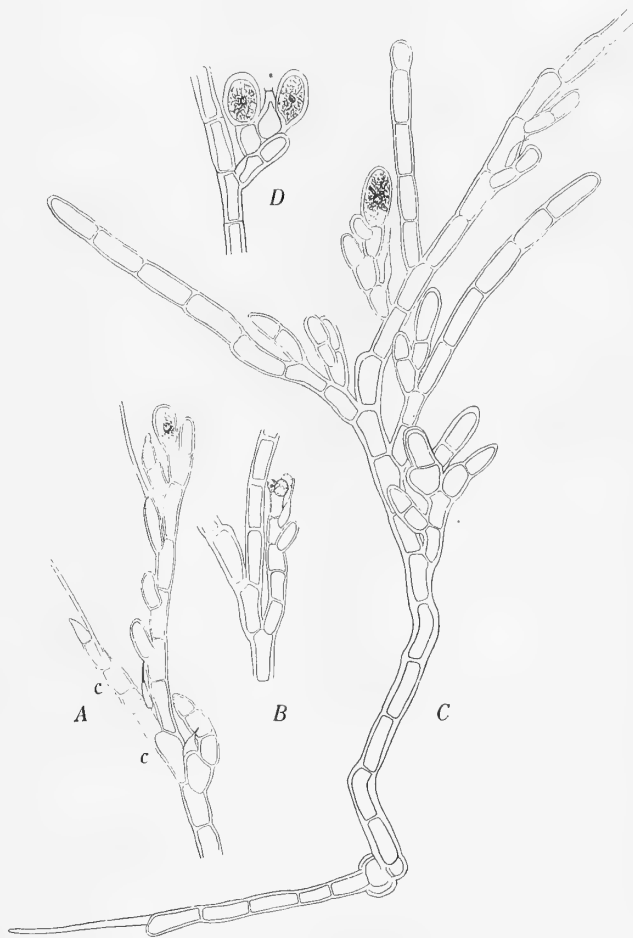


Fig. 22.

Chantrelaria hallandica α , typical. A, fragment of plant with abortive carpogonia and sporangia. B, branchlet with antheridia and carpogonium. C, plant with abortive carpogonia and probably unripe cystocarps. D, cystocarp, at * perhaps the place of the trichogyne. 530:1.

All plants from AH¹.

from the cylindric form (fig. 23 C). These plants are lower than the main form and usually branched from the base, while the main form is most often without

branches below. In the specimens from VT the sporangia were almost always sessile, alternate, secund or opposite (fig. 23 A), while in the specimens from KC they were often stalked (fig. 23 C). This form may be named *f. brevior*.

The specimens just described are only slightly different from others agreeing with KYLIN's *Ch. parvula*. Fig. 25 shows such a specimen, the filaments of which are 5—7 μ thick and the cells about

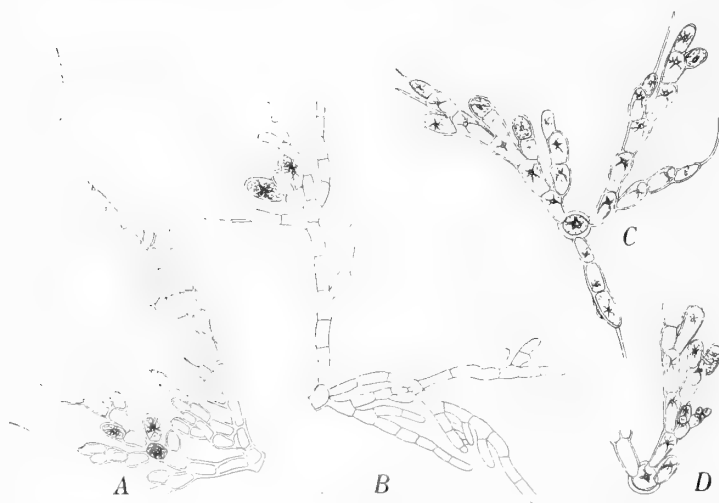


Fig. 23.

Chantransia hallandica ♂, *brevior*. A and B from VT. A with sporangia, B with sexual organs and a cystocarp. — C and D from KC, C with sporangia, partly stalked, D with sporangia and antheridia. 390:1.

twice as long as broad; the sporangia, however, were somewhat larger than indicated by KYLIN, namely (10—) 12—13 (—14) μ long, 6—8 (—9) μ broad. The basal cell was (10—) 12—13 (—15) μ in diameter. Some specimens growing on the frond of *Porphyra umbilicalis* on the mole of Frederikshavn (fig. 26) may also be referred here, though they were not strongly ramified in one plane; they bore numerous sporangia, most often opposite, sometimes even three in one article. The axile chromatophore is very distinct in the figures which have been drawn after specimens preserved in alcohol. The last-named specimens as well as those from EM (fig. 25) were only provided with sporangia; on the other hand, specimens from BH (fig. 24) had also sexual organs. Fig. 24 B fully agrees otherwise with KYLIN's figures, while fig. 24 A might perhaps be better referred to *f. brevior*, but these plants grew side by side and were connected by transitional forms. A very reduced plant provided with all kinds of organs of reproduction is shown in fig. 24 C. It seems not improbable that the small cells shown in KYLIN's fig. 9 h, i (1906) may have been antheridia.

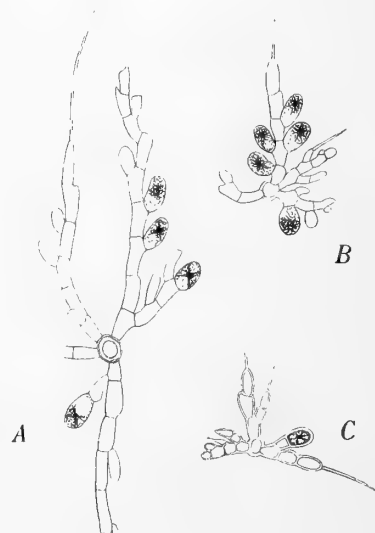


Fig. 24.

Chantransia hallandica ♀, *parvula*. From BH. A with longer cells and alternate sporangia, B with sporangia and antheridia, C, dwarfed plant with sporangium and sexual organs. 390:1.

From what has been explained above it may be concluded that all the specimens mentioned must be referred to one species, *Ch. hallandica*, which may be divided into three forms not separable by distinct limits.

a, *typica*. From the basal cell are given off usually three upright filaments which are branched on all sides, usually without branches below, 5–6 μ thick. Cells ca. 4 times as long as broad. Sexual organs and sporangia present, often in the same plant, the sporangia usually alternate, often stalked.

β , *brevior*. Cells ca. 2 ($1\frac{1}{3}$ –3) times as long as broad, primary filaments often branched from the base. For the rest as *a*.

γ , *parvula* (Kylin). (Syn. *Ch. parvula* Kylin l.c.). From the basal cell are given off up to 6 filaments which are (5–) 6–7 μ thick. Cells ca. 2 times as long as broad. Sporangia almost always sessile, most frequently opposite. Sexual organs often wanting.

The species has almost always been found epiphytic on *Polysiphonia nigrescens* and *Pol. violacea*. *F. parvula* has also been found on *Porphyra umbilicalis*. It has only been met with in the summer months (May–August), in all cases with sporangia and usually also with sexual organs; ripe cystocarps have been met with in July and August. *a* and *β* have been found in depths of 4 to 15 meters, *γ* in depths of 0 to 9,5 meters.

Localities. **Kn**: Krageskovs Rev, KC, (*β*); Hirsholm, (*β*); Frederikshavn, (*γ*); VT, N. of Nordre Rønner, (*a* and *β*); Trindelen, FF, 15 meters. — **Ke**: XA, 13 meters, (*a*). — **Km**: VQ, Svitringen, (*a*); BH, off Gjerrild Klint, (*γ*). **Ks**: EM, Lysegrund, (*γ*). — **Sa**: BD, N. of Tunø; MQ, (*β*); AH¹, N. of Fyens Hoved, (*a*). — **Lb**: At Fænø, (*a*). — **Sb**: AB, W. of Sprogø, 7,5 meters (*a*). — **Bw**: LC, S. of Langeland, 11,5 meters, (*a*).

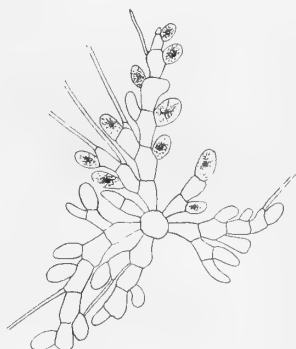


Fig. 25.
Chantransia hallandica γ , *parvula*. From EM. Plant with sporangia only. 390:1.

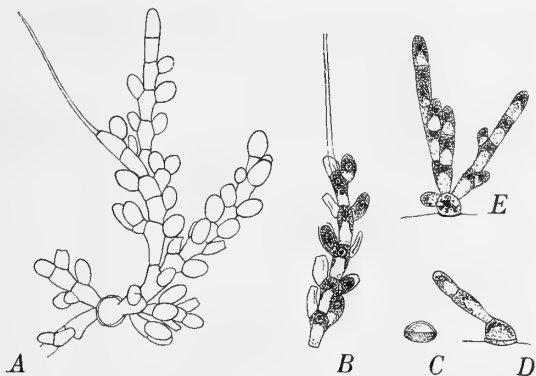


Fig. 26.
Chantransia hallandica γ , *parvula*. From Frederikshavn, growing on *Porphyra umbilicalis*. A, plant with sporangia. — B, filament with partly emptied sporangia. — C, germinating spore. — D and E, young plants, still sterile. 300:1.

Cellulæ (5–) 6–7 (–9) μ crassæ, in filis bene evolutis diametro 4–6 (–7)-plo longiores, chromatophorum axile, pyrenoide centrali instructum, in parte superiore cellulæ situm, continentes. Sporangia monospora ovata, 12–16 μ longa, 8–10 μ lata, vulgo c. 14 μ longa, 10 μ lata, in filis primariis lateralia vel terminalia, sessilia vel stipitata, in stipite unicellulari singula, in articulis filorum sæpe bina, opposita,

4. *Chantransia baltica* sp. nov.

E cellula basali globosa, diametro 10,5–14 μ , fila usque 6 subsimplicia, longitudine 400 μ vel ultra, egrediunt.

superne nonnunquam subsecunda. Organa sexualia desunt. Pili hyalini crebri, in ramulis sporangiferis terminales.

This species which has been found only in two localities in the Baltic is certainly nearly related to *Ch. hallandica*, but however so different from it, that I do not hesitate to set it up as a distinct species. It differs by the primary filaments

being more numerous, less branched, somewhat thicker and consisting of somewhat longer cells, by the sporangia being larger, by the sporangial stalks bearing only one sporangium, and by the want of sexual organs. In some of the characters mentioned, the more numerous and thicker filaments, and the sporangia often opposite, it resembles *Ch. hallandica* f. *parvula*, but it is very different from this by the long cells and the sporangia being often stalked.

To complete the description given above, the following remarks may be added. The basal cell is nearly globular, its plane of attachment being often smaller than its transverse section; it is rather thick-walled. The primary filaments bear usually no long branches but only sporangia-bearing branchlets. The most developed primary filaments recall somewhat those of *Ch. virgatula*, but they are thinner and the branchlets bear only one sporangium. The shorter filaments consist of shorter cells, 2–3 times as long as broad and often somewhat enlarged above. In some specimens from SQ the longer

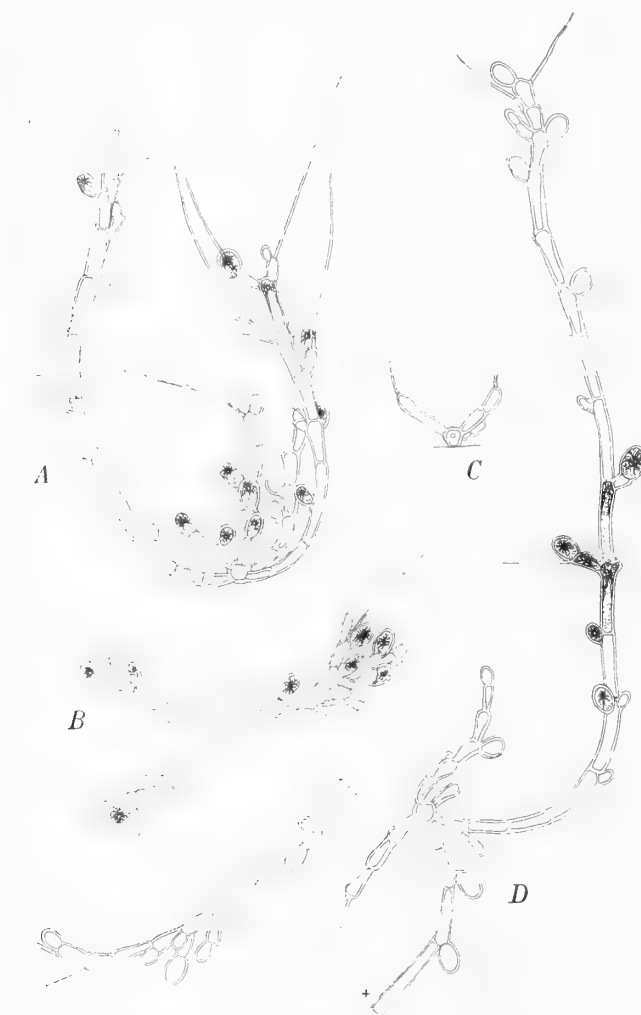


Fig. 27.

Chantrelaria baltica. (From QR). A, B and D, fully developed plants with sporangia. C young plant, seen from the side. 300:1.

filaments were up to 9μ thick below, upward thinner, ca. 5μ in diameter, the cells being up to 7 times as long as broad. The chromatophore reaches in the longer cells often only to the middle of the cell, the pyrenoid lies near the upper end of the cell. The spores contain a very distinct stellate chromatophore. I have never

seen a sporangial stalk bearing more than one sporangium, and a renewal of an emptied sporangium within the sporangial-wall from the stalk-cell has not been observed, but a new sporangium may sometimes be developed beside an emptied. Colourless hairs are always present; they are terminal or lateral, in the latter case, however, certainly always originally terminal.

Localities. **Bm**: Gyldenløves Flak, QR, 7,5 meters, on *Polysiphonia violacea*, July. — **Bb**: S. of Broens Rev, 8,5 meters, on *Polysiphonia elongata*, August.

5. *Chantransia moniliformis* sp. nov.

Thallus minutus cæspitosus, 50—150 μ altus vel parum ultra (sine pilis). Cellula basalis singula subglobosa, fila 2—3 (vel plura?) erecta vel decumbentia et adscendentia, a basi ramosa, e cellulis plus minus inflatis constituta, emittens. Cellulæ diametro æquilongæ ad duplo longiores, plerumque fere sesquilongæ, subglobosæ aut doliiformes vel in parte superiori incrassatæ, 7—10 μ latæ, 7—14 μ longæ. Chromatophorum stelliforme, pyrenoide centrali instructum, in parte superiori cellulæ situm. Fila ramique, præcipue in statu juvenili, sæpe piligeri, pilis initio terminalibus, dein evolutione sympodiali (pseudo-)lateralibus. Sporangia monospora sessilia, rarius pedicellata, lateralalia, secundata vel opposita, ovata, 13,5—15 μ longa, 7 μ lata, post evacuationem sæpe sporangio novo, e cellula subjacenti orta, repleta. Organa sexualia ignota.

This small species is easily distinguishable from the other species of this group by its short, more or less swollen cells, which in juvenile plants approach to the globular form, while in older plants they are almost barrel-shaped. The basal cell which is fixed to the host plant by a thin layer of cementing substance is scarcely different from the other cells in form. The displacement of the originally terminal hairs is easily to be seen in the young plants (fig. 28 C); in older plants no hairs are to be found. In the plant represented in fig. 28 B the cell situated beneath the upper terminal hair-cell had lengthened and become almost colourless, approaching thus to the character of a hair-cell; but this case appears to be very rare. The branches are mainly given off at the upper side of the decumbent or ascending principal filaments, and this holds good also of the sporangia which are often seriate on the upper side of the filaments. After the evacuation the sporangial wall is seen to be lamellate, but the acroscopic part of it is often dissolved (fig. 29 B). — On dried material I once saw a specimen with a blue-green colour; unfortunately I have not examined the species in the living state.

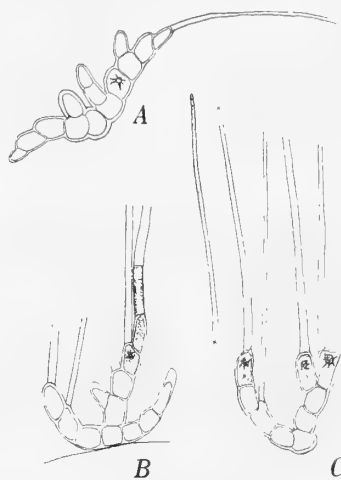


Fig. 28.
Chantransia moniliformis. Young plants with hairs. A from Helsingør, B and C from D. 390:1.

This inconspicuous species has been found epiphytic on *Polysiphonia violacea* and *nigrescens*, in company with other species of *Chantransia* (*virgatula*, *hallandica* etc.), at several places but in small quantities.

It has been met with in May to September, in depths from 1 to 11,5 meters, and was collected with sporangia in the same months.

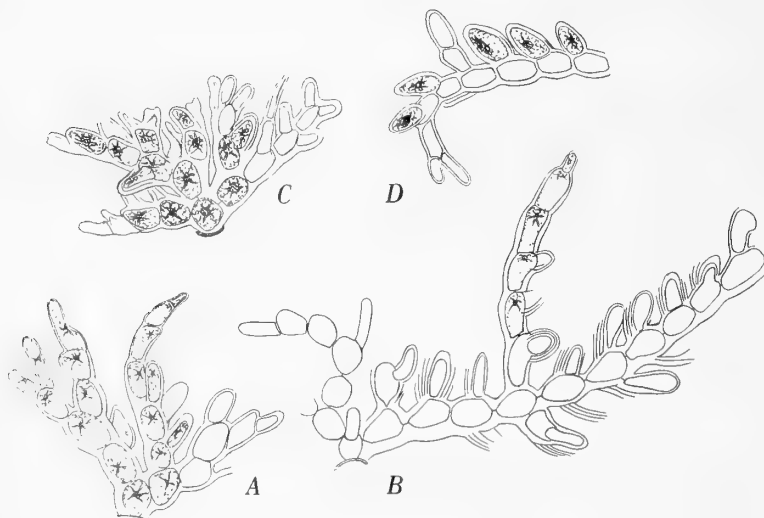


Fig. 29.

Chantransia moniliformis. Adult plants with sporangia. A—C from Helsingør, September, D from AH¹. In D full-grown sporangia, in B the sporangia have been emptied and new sporangia are developing within their membranes. 390:1.

Localities. **Kn**: Krageskovs Rev, KC. — **Ks**: D, N. of Isefjord, 11,5 meters. — **Sa**: AH¹, N. of Fyens Hoved; MQ, S. of Samsø, 11,5 meters. — **Su**: Stone-slope at Helsingør (Kronborg). — **Bw**: LC, S. of Langeland, 11,5 meters. — **Bm**: QR, Gyldenløves Flak.

Group II. Frond epiphytic with a pluricellular basal layer.

6. *Chantransia Thuretii* (Born.) Kylin.

Kylin (1907) p. 119.

Chantransia efflorescens var. *Thuretii* Bornet (1904) p. XVI pl. I.

α, *amphicarpa* nob.

Of this species, which is quite distinct from *Ch. efflorescens* (J. Ag.), as shown by KYLIN, I have found specimens fully agreeing with KYLIN's description and drawings. Such specimens, provided with monosporangia and sexual organs, were met with repeatedly in July near Frederikshavn. In some cases the sporangia and the sexual organs occur on different branches of the same plant, but as shown by KYLIN, the sporangia are often situated near the sexual organs, and all the three kinds of organs of reproduction may then occur very close together, as is seen in fig. 30 B, where the same cell bears a carpogonium and a sporangium, while a cluster of antheridia is situated on the next branchlet. Also in fig. 31 B, the sporangium is situated close to the carpogonium and in fig. 31 A a two-celled branchlet is seen to bear a carpogonium, an antheridium and a sporangium.

When not occurring together with the sexual organs the sporangia are situated on the inner side of the branches near the base, usually 2 or 3 together on one-celled branchlets, or they are sessile at the same place; more rarely the branchlets are 2- or 3-celled. It may sometimes happen, that two sporangiferous branchlets are seated on the same cell, the one over the other (fig. 30 A). On maturation the spore leaves

the sporangium through a narrow opening at its upper end. After liberation, which was observed in July, the spores took an ovoid form, thereafter they became globular and then showed amoeboid movements.

The germinating spore forms an orbicular basal cell which gives off one upright filament but for the rest remains unaltered for some time (fig. 30 *D*); later on it forms cells in the periphery which grow out in creeping filaments fusing together to a rather large-celled basal disc, which produces more upright filaments (fig. 31 *C*). The original basal cell is for some time distinguishable in the centre of the disc. As shown by KYLIN, no downwards growing filaments occur at the base of the upright filaments. However, I have once observed two short vigorous descending filaments given off very near the base of an upright filament, and each producing an upright filament on its convex side (fig. 31 *D*).

The chromatophore, the form of which KYLIN was not able to determine, is shown in fig. 30 which was drawn after living plants; it is a parietal plate, often with a lobed margin and with a large pyrenoid which is also parietal but much projecting inward in the cell. The nucleus often lies at the opposite side of the cell from the pyrenoid (fig. 30 *B, C*).

Plants similar to those mentioned above were found at a locality in the Samsø Waters in September. They were, however, only provided with ripe cystocarpia and bore no sporangia, perhaps to be explained by the sporangia accomplishing their development faster than the cystocarps.

Referring for the rest to KYLIN's description, I may remark finally, that the filaments in my plants were 7,5—9,5 μ thick, that I have once observed a pair of opposite branches, that the sporangia were 14—16 (—17) μ long, 9—11 μ broad, and that the carpospores were 19—21 μ long, 11—12,5 (—14) μ broad.

The main form has been found growing on *Polysiphonia violacea*, *Ceramium rubrum*, *Cystoclonium* and *Dictyosiphon*, with sexual organs and ripe carpospores and monospores in July, with ripe carpospores in September.

Localities. **Kn**: Busserev by Frederikshavn, July. — **Sa**: MP, Falske Bolsax, 11—13 meters.

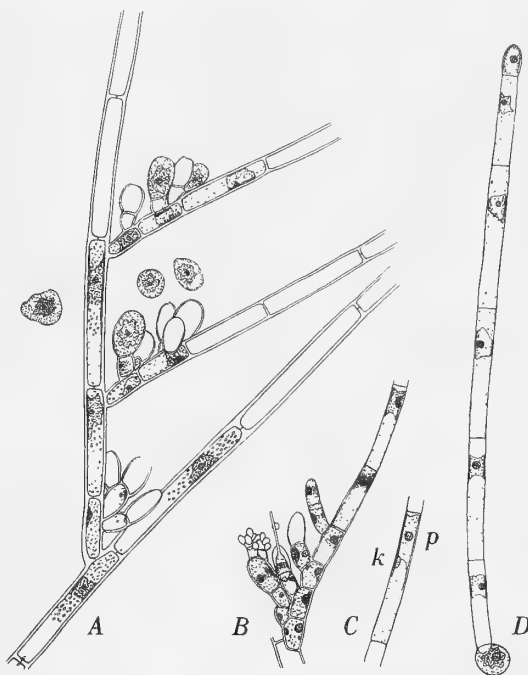


Fig. 30.

Chantransia Thuretii *a.*, *amphicarpa*. Drawn after living plants from Busserev by Frederikshavn. *A*, plant with sporangia and liberated spores. *B*, branch with branchlets bearing antheridia, a carpogonium and sporangia; behind the carpogonium an emptied sporangium is visible. *C*, cell with chromatophore, pyrenoid *p* and nucleus, *k*. *D*, young plant. 320:1.

β, agama var. nov.

In the Danish waters plants only provided with sporangia are much more frequent than the above described sexual plants. As they greatly resemble these, I conclude that they belong to the same species; as they are different, however, not only by the want of sexual organs but also by somewhat larger sporangia they may be mentioned separately; and this will appear all the more legitimate when we remember the great likeness between the sporangia-bearing filaments of *Ch. Thuretii* and those of *Ch. corymbifera* Thur. (BORNET et THURET 1876 pl. V), so that it is not excluded that the specimens mentioned here might represent a separate species.

As to the vegetative organs this form agrees with the sexual plants; the prin-

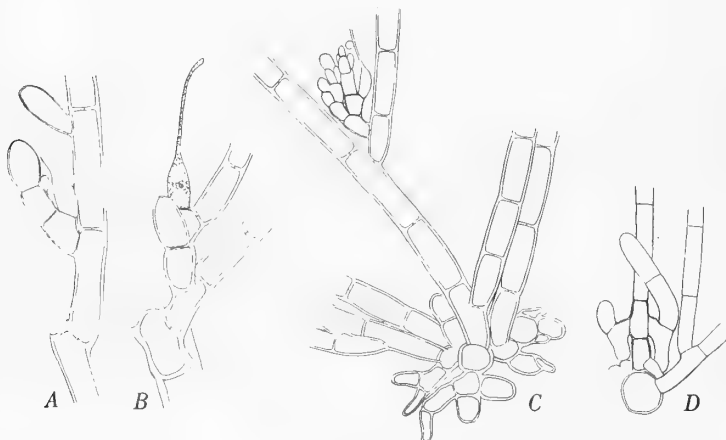


Fig. 31.

Chantransia Thuretii α, amphicarpa. From Busserev by Frederikshavn. A, the branchlet bears a carpogonium, an antheridium and a sporangium. B, the branchlet bears a terminal carpogonium and a lateral empty sporangium. C, lower part of a plant; above a branchlet with antheridia and a carpogonium. D, lower part of a plant with two short descending filaments. A, B 560:1, C, D 350:1.

incipal filaments, however, are as a rule a little thicker, namely 8—11 μ in diameter. In some cases the thickness reached 12 μ , and in some specimens from the North Sea (aF, fig. 32 F) it attained even 13 μ . On the other hand principal filaments only 7 μ thick may also occur. The cells are, as in the sexual plants, rather thick-walled; in the lower part of the filaments they are proportionally short (seldom however so short as in fig. 32 A), upward longer.

The branches are somewhat thinner than the principal filaments and become thinner towards the apex. Sometimes they taper into very thin hair-like threads consisting of long, thin cells, the contents of which become colourless (fig. 32 B); this may also occur in α . Descending filaments at the base of the plants were not observed in typical specimens of this form. The chromatophores have the same shape as in the sexual plants.

The sporangia have the same position and shape as in the sexual form but are somewhat larger. The length is usually 19—22 μ , but it may attain 24 μ and may sometimes be only 17,5 μ ; the breadth varies between 8 and 12 μ (7—13 μ). Only once have I seen a sporangium or a sporangium-bearing branchlet situated beneath another sporangium on the same cell (fig. 32 C, comp. fig. 30 A). In specimens collected towards the end of September in the Northern Kattegat (TP),

some peculiar crooked branchlets were observed, mostly rising from the sporangia-bearing branchlets, more rarely independently of these, and then usually given off from the lower end of the cells (fig. 33); in some cases they bear sporangia (fig. 33 A). Sometimes they occur in great number on a branchlet, forming a short-stalked capitulum (fig. 33 B). These crooked filaments showed rich, coloured contents; they must without doubt be regarded as abnormal formations.

Besides the monosporangia tetrasporangia have also been met with, but only in one locality in the North Sea (aF, 31 meters) in August. The specimens bore numerous, typical monosporangia and in smaller number tetrasporangia, having a similar position to the former. The number of tetrasporangia on one branchlet was frequently greater than usual, but that was also the fact for the monosporangia in these specimens. The tetrasporangia were almost globular, a little longer however than broad, $25\text{--}26\ \mu$ long, $21\text{--}22\ \mu$ broad (fig. 32 D).

In one branchlet only one sort of sporangia occurred, but branchlets with monosporangia were found at a little distance from those with tetrasporangia on the same plant. Some plants bore only monosporous sporangia.

Some specimens growing on *Flustra foliacea* dredged in the Skagerak N.W. of Hirshals in May (no. 7109) may be mentioned here, as they are somewhat different in the smaller size of the sporangia and the more irregular position of the spor-

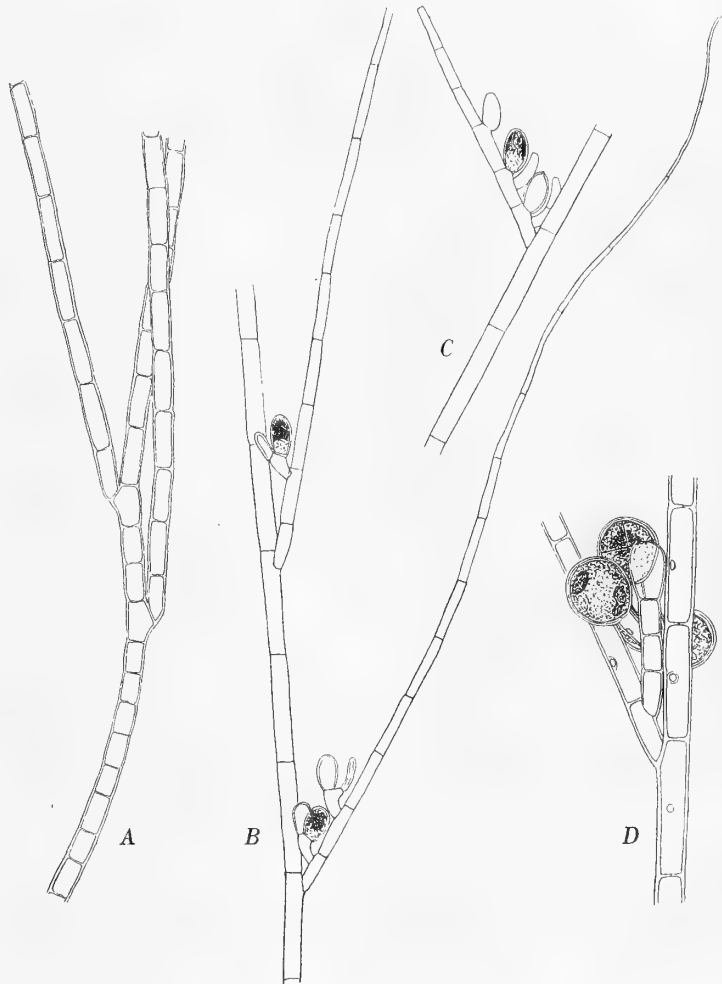


Fig. 32.

Chantransia Thuretii β , agama. A—C from ZL¹. 265:1, A from the lower, B from the upper part of the plant. C, branch with sporangia, partly 2 on each cell. D, from aF. 345:1, branchlet with tetrasporangia. The pyrenoids have been drawn in some of the cells.

angia-bearing branchlets. These were namely not restricted to the inner side of the branches but occurred on all sides of the filaments and at various distances from the base, and the sporangia were usually only $11-14\ \mu$ long, $7.5-8\ \mu$ broad; one, however, was found to be $16\ \mu$ long, $9.5\ \mu$ broad. The sporangia were for a great part emptied, and new were formed within the sporangial wall from the underlying cell. As these specimens agreed otherwise with the f. *agama*, and as they were found only in very small number, I may content myself with just naming them here; it need only be pointed out that they showed short descending filaments near the base.

Ch. Thuretii β , *agama* occurs in depths of 2—31 meters. In the Limfjord it has been observed in depths of 2—7 meters, in the other waters only in depths greater than 9.5 meters. It has been found growing on 14 different species of Algæ, as species of *Polysiphonia*, stipes of *Laminaria*, *Delesseria sanguinea*, *Gloiosiphonia*, *Desmarestia aculeata*, *Fucus serratus*, further on *Zostera*-leaves and on *Flustra foliacea*. It has only been found in the months June to September, except the above named, somewhat aberrant specimens collected in May. Ripe sporangia have been met with in all the months named.

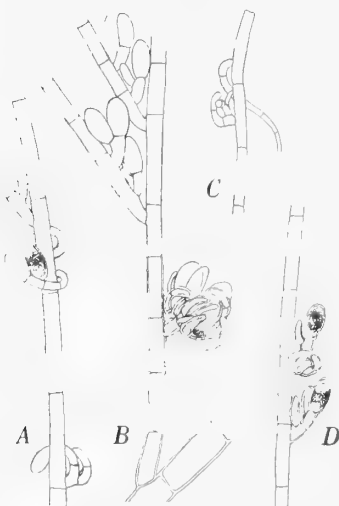


Fig. 33.

Chantransia Thuretii β , *agama*. From TP. Parts of filaments with crooked branchlets rising mostly from the sporangiferous branchlets. 300:1.

Localities. Ns: aF, 31 meters. — Sk: ZK⁶ off Lønstrup, 11—13 met.; (? N.W. of Hirshals, 13—15 met., May, no. 7109). — Lf: ZU, 3 met., and XU, 4 met., in Nissum Bredning; MH in Thisted Bredning; off Grønnerup in Sallingsund, ca. 2 met.; LS and MI East of Mors. — Kn: Herthas Flak, 20—22.5 met. (!, Børgs.); Frederikshavn; ZL¹ N. of Læsø, 9.5 met.; FF and TP, Trindelen, ca. 15 met. — Kc: Fladen, 22.5 met. — Ks: EM, Lysegrund. — Sa: MQ, S. of Samsø, 11.5 met. — Lb: N. of Fænø Kalv, 13 met.

7. *Chantransia Daviesii* (Dillw.) Thur.

THURET in LE JOLIS Liste p. 106; KYLIN (1907) p. 117 fig. 27.

Conferva Daviesii DILLWYN, Brit. Conf. 1809 p. 73, pl. F (teste specim.).

Callithamnion Daviesii HARVEY, Phyc. Brit. pl. 314; J. AGARDH Sp. III p. 8.

Acrochetium Daviesii NEGELI (1861) p. 405; BARNET (1904) p. XXII.

This species is as a rule easily recognizable by its fairly thick, thick-walled and short-celled filaments and by its fasciculated sporangia-bearing branchlets. It is undoubtedly nearest related to *Ch. Thuretii* which it may sometimes very closely resemble, while it is very different from *Ch. virgatula* with which it was formerly often confused. Although it was the first described of all the marine species of the genus, it is imperfectly known in some respects, for which reason a short description of the Danish specimens may be given here.

The basal part consists of branched creeping filaments which may become so densely interwoven that they form a continuous basal disc. When the plant is growing on an irregular surface, as e. g. the stalk of *Laminaria hyperborea*, the filaments are very irregularly curved and may grow over one another, and the basal

part may thus become two or even three cells thick, as stated by HARVEY GIBSON (Journ. of Bot. 1892 p. 104), but a real parenchymatous disc I have never seen. From the basal layer numerous erect filaments appear, forming 6 mm. high clusters. The filaments are usually 9–12 μ thick, but the thickness may vary from 8 to 13 μ . The cells are usually 2–4 times as long as broad (more rarely 1–5 times). The cells contain a parietal chromatophore with a well developed pyrenoid, very prominent in the interior of the cell; sometimes the pyrenoid is so large that the part of the chromatophore in which it lies reaches nearly to the part of the same chromatophore on the opposite side of the cell (fig. 34 *F*). According to KYLIN (1907 p. 118) hairs rarely occur, a sporangia-bearing branchlet terminating in a hair instead of a sporangium. I have never seen unicellular hyaline hairs; on the other hand the fertile branchlets were often found tapering into very thin hair-like filaments, the cells of which become longer and thinner and decoloured upwards (fig. 34 *C*), as in *Ch. Thuretii*.

The sporangia are always situated on branchlets which are more or less branched; the most vigorous are repeatedly branched and consist of at least 3 generations of branches, the youngest of which is situated on the inner side of the foregoing, so that the branchlet gets the form of a fan-shaped fascicle. These branchlets are mainly placed in the axils of the branches, on the inner side of their undermost cell, but they may also occur scattered on the sides of the principal filaments. In the first case one fascicle only is placed in each axil, especially when the branchlet is well developed, but not rarely two less branched branchlets are placed the one over the other (fig. 34 *D*), and there is then a resemblance with *Ch. Thuretii*; typical sporangia-bearing fascicles are, however, always to be found on the same plants. I found

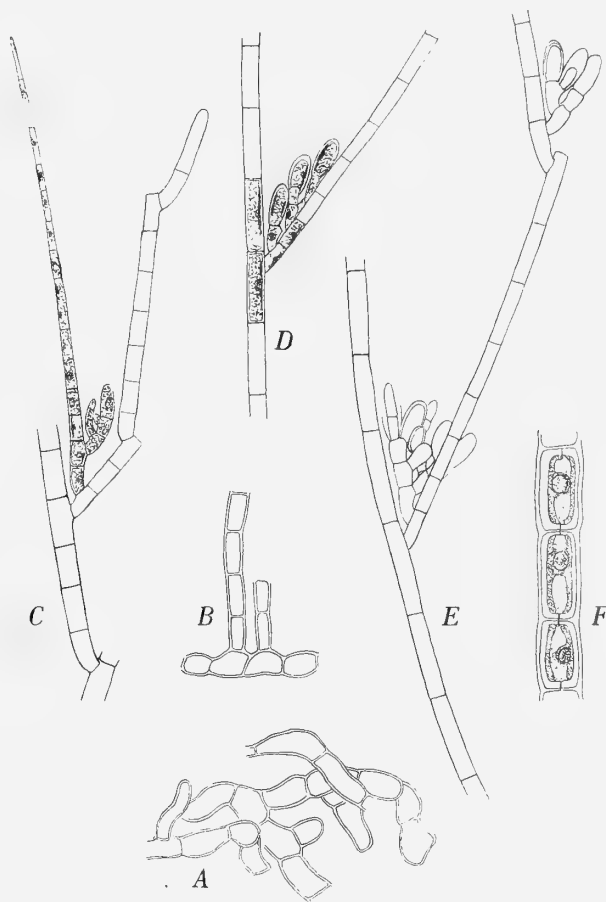


Fig. 34.

Chantransia Daviesii. *A* and *B*, basal parts of plants growing on the stalk of *Laminaria digitata* seen from above and from the side. *C*–*E*, erect filaments with sporangia-bearing branchlets. *F*, three cells showing the chromatophore (December). *A*–*E* 300:1, *F* 390:1.

always only monosporangia, but KYLIN states (1907 p. 118) that tetrasporangia may occur together with the monosporangia. The size of the sporangia was found to be somewhat different, the length varying from 11 to 19 μ , the breadth from 8 to 10 μ . It seems however that two groups of sporangia are distinguishable with regard to the size, the one being 11—14 μ long, 8—9 μ broad, the other 15—19 μ long, 9—10 μ broad, and one kind of sporangia is always only to be found on the same plant. As I have not found these differences of size connected with other differences, I have not thought it necessary to distinguish the two kinds of individuals.

It will be seen from the above that this species must be considered related to *Ch. Thuretii*; it differs from the asexual form of this particularly by somewhat thicker filaments, shorter cells and smaller sporangia being placed, at any rate in part, on repeatedly branched branchlets situated in the axils of the branches.

The species occurs epiphytically on various Algæ, especially *Laminariæ*, on the stalks as well as on the blade, in particular on the borders of the segments of the digitate species; further it has been met with on *Flustra foliacea* and once on *Littorina littorea*. It has been collected in 1 to 23,5 meters depth. It is certainly perennial or may be so. It has been found, in all cases with sporangia, in the months of May to December, in November and December in a great measure with empty sporangia.

Localities. **Ns**: aD, 23,5 met. — **Sk**: N.W. of Hirshals, 11 to 15 met. — **Kn**: XK, TX and TU near Hirsholmene; Krageskovs Rev, 5 met.; port of Frederikshavn; Busserev; Borrebjergs Rev; TP, Tønneberg Banke, 16 met. — **Ke**: Lille Middelgrund, on *Odonthalia*, 17 to 19 met. — **Sb**: Kerteminde, 9,5 to 11,5 met., on *Littorina littorea*.

8. *Chantransia attenuata* sp. nov.

Discus basalis bene evolutus, unistratosus, e filis repentibus confluentibus, cellulis fere isodiametricis, constructus. Fila erecta sat numerosa, parce ramosa, apicem versus sensim attenuata, usque ad 550 μ longa, basi 6,5—7 μ , superne c. 5 μ crassa, cellulis inferioribus diametro c. duplo, superioribus 3—4-plo longioribus. Chromatophorum ut videtur unicum parietale, pyrenoide laterali instructum. Rami sparsi vel oppositi. Crescentia apicalis sæpe sistitur, formatione pili vel sporangii (?), et rami oppositi infra apicem extinctum egrediuntur. Monosporangia 7,5—9 μ longa, 4,5—6 μ lata, in ramulis unicellularibus solitaria vel bina, vel in ramulis majoribus plura sessilia, pedicellata et terminalia conferta.

This species has only been met with once, growing on *Desmarestia aculeata* dredged in the Limfjord in August, and was then in a rather advanced stage of development. As moreover I have had only rather few dried specimens for examination, my description is in some respects incomplete; the species seems, however, to be distinct from all known species.

The well developed basal layer resembles that of *Ch. Thuretii*. As the most striking character may be mentioned the frequent occurrence of opposite branches, which, however, were only found when the growth of the filament was stopped

seemingly by the formation of a terminal hyaline hair. The hair had usually disappeared, leaving only a faint scar, in some few cases it was still visible (fig. 35 B). The principal filaments consist in their lower part of short cells, about twice as long as broad; upwards the filaments become gradually somewhat thinner, and the cells at the same time longer. On the whole, the filaments are not much branched. Owing to the defective state of preservation of the material I have not been able to determine with certainty the form of the chromatophore. In some cases, however, I have seen that it is parietal, and I suppose it to be single and to have one parietal pyrenoid.

The position of the sporangia is somewhat variable; they occur mostly in the upper part of the plant and are relatively often placed singly, more rarely two together on unicellular branchlets, or they are, though rarely, sessile on the filaments. Sometimes a greater number is placed on somewhat larger, often branched branchlets, but



Fig. 35.

Chantransia attenuata. A, plant the basal layer of which is seen from the under face. 350:1. B and C, upper ends of filaments with sporangia. 560:1.

such branchlets grade evenly to the long filaments. The sporangia-bearing branchlets show usually no distinct arrangement on the filaments.

The species is perhaps related to *Ch. Thuretii*; it differs from it by the opposite branches and the small sporangia.

Locality. Lf: MA in Nissum Bredning, 5 meters, on *Desmarestia aculeata*.

9. *Chantransia stricta* sp. nov.

Discus basal is unistratosus e filis lateraliter confluentibus compositus. Fila erecta pauca e centro disci egredientia simplicia vel subsimplicia, stricta, usque ad 1 mm. et ultra longa, 6—7 μ crassa, ramulos sporangiferos per totam fere longitudinem gerentia; cellulae 3—4,5 diametra longae, chromatophorum parietale, pyrenoide instructum continentes. Ramuli sparsi, nonnunquam secundati, erecti, uni—bicellulares, monosporangia 2—3 gerentes, nonnunquam piliferi. Sporangia anguste ovata, (12—) 13—14 μ longa, (5—) 6—7 μ lata.

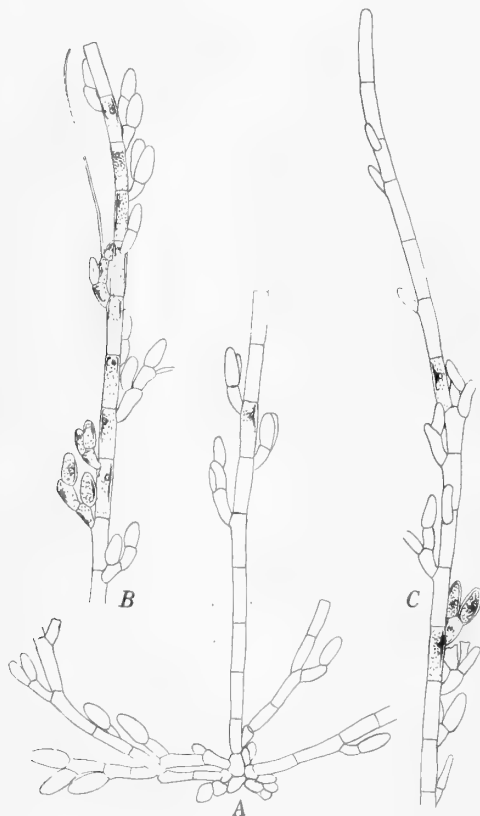


Fig. 36.

Chantransia stricta. A, lower part of a plant, B, fragment of the middlemost part, and C, the upper part of the same plant. 350:1.

This species is characterized by its straight erect filaments which are unbranched or bearing at most a single branch of the same kind as the principal filament. The direction of this is usually not at all influenced by the numerous lateral fertile branchlets, one of which is usually placed on nearly every one of the cells from the base to the top. The branchlets are situated on all sides of the filament, but not infrequently a number of consecutive branchlets are placed on the same side (fig. 36 C). Most of the branchlets are unicellular and bear 2 sporangia, but two-celled branchlets are also frequent, while such consisting of more than two cells are rare. In well developed filaments sessile sporangia do not usually occur, but they may be found in feebly developed filaments (fig. 36 A at left). Hairs are often met with at the end of the branchlets and marks of decayed hairs are frequently visible. The sporangia are relatively narrow, twice as long as broad. As I have only had occasion to examine a small number of dried specimens, I cannot give any information on the development of the basal layer.

As far as I can see, this species cannot be identified with any of the more exactly described species. The nameless species described by REINSCH (Contrib. ad Alg. et Fung. 1877 p. 38 pl. XII fig. 1—2) which also has unbranched filaments, (setting aside the branchlets) differs among other things by its much smaller dimensions, shorter cells, less erect branchlets and more roundish sporangia.

Only found in small quantity together with other species of *Chantransia* on *Polysiphonia nigrescens* in depths of 7,5 to 11,5 meters, in July and August.

Localities. **Km**: BH off Gjerrild Klint. — **Ks**: D, N. of Isefjord. — **Sa**: AH¹ off Fyens Hoved.

10. *Chantransia virgatula* (Harv.) Thur. emend.

I have for a long time been in doubt whether the forms mentioned under this species ought to be regarded as distinct species or as forms of one species. It is easy to point out within this group of forms some fairly different types, and I tried at first to carry out the first alternative, but I then repeatedly met individuals which might apparently with equal right be referred to one or other of the presumed species. As the delimitation of the species seemed not to be facilitated by the establishment of new species embracing the intermediate forms nor by division otherwise of the forms, I have ended by referring them all to one species. My observations have led me to the view, that this species is able to take various forms under different conditions. I dare not deny that any form referred to it may possibly prove on closer examination to be a distinct species, but as I have not been able to draw the limits, I have judged it best to keep them together.

The species was first described by HARVEY in 1833 and figured by the same author in Phyc. Brit. pl. 313 (1851), where it was represented with tetrasporangia, showing even partly tetrahedral division. The last must at all events be wrong, and it has also been supposed by THURET (Le JOLIS Liste p. 104) and later authors that the statement of tetrasporangia was founded on some mistake. It was then generally accepted, that this species, as well as all other species of *Chantransia*, had only monosporangia, until SCHMITZ and HAUPTFLEISCH briefly mentioned (1896 p. 331) that tetrasporangia may occur together with the monosporangia in *Ch. secundata*. Later the same was observed in *Ch. virgatula* by BØRGESSEN and KUCKUCK (BØRGESSEN 1902 p. 351), and the observation of SCHMITZ was confirmed by BØRGESSEN (l. c. p. 350) and KYLIN (1907) for *Ch. secundata*. I have also found tetrasporangia in the latter but in particular in a form coming near to the typical *Ch. virgatula* (f. *tetrica*).

As will be shown below, the forms referred to this species differ principally in the nature and intensity of the ramification, the length of the cells and the number of spores in the sporangia; in other respects they are quite alike. Thus, the structure of the cells is the same. The chromatophore contains an axile pyrenoid situated in the upper part of the cell and gives off a number of branches downwards and upwards; under the chromatophore a nucleus is visible. The germination takes place in the same manner in all the forms, the germinating spore dividing by excentric walls into an inner triangular and three peripheral cells, without changing the orbicular outline (figs. 37 *C*, 38 *A—C*, 39 *C—D*, 40 *E*, 41 *A*), (comp. MURRAY and BARTON (1891) p. 212 pl. 37 fig. 5; KYLIN (1907) fig. 24). Some small differences may sometimes occur (fig. 40 *F*), but the greater part of the spores germinate as described. The orbicular outline of the basal disc may sometimes hold out for a long time, in other cases some of the peripheral cells grow out to creeping filaments at an early period (figs. 39, 40). The number of erect filaments given off from the basal disc is usually low; the first is produced by the central triangular cell, the following from the neighbouring cells.

a, luxurians (J. Ag.).

Callithamnion luxurians J. AGARDH Sp. II p. 14.

Chantransia luxurians KYLIN l. c. p. 117 fig. 26.

Callithamnion virgatulum CROUAN Alg. mar. Finist. p. 116.

Chantransia virgatula THURET in Le Jol. Liste p. 106; KYLIN (1907) p. 116 fig. 25; BORGESEN, M. A. Fær. p. 351 fig. 52.

Trentepohlia virgatula FARLOW Mar. Alg. New Engl. p. 109 pl. X fig. 3.



Fig. 37.

Chantransia virgatula a, luxurians. A, part of plant with sporangia. B, basal part. C, basal part of young plant. 260:1.

This form which corresponds to the *Ch. virgatula* in the common restriction of the authors is the commonest form in the Danish waters. It has two or three generations of long filaments, which are straight, up to 2 mm. long, 10 to 14 μ thick, more rarely up to 16 μ thick or even thicker, consisting of cells 3 to 5 times as long as broad. There is a distinct contrast between the long filaments and the branchlets which occur in great number, one or two on each cell of the filaments, in the first case often second, in the latter usually opposite; they are usually 1 to 3 cells high, unbranched or branched and bear generally two or more sporangia and most frequently also one or more vigorous hairs. The sporangia are monosporous, ovate or broadly ellipsoidal 17—21 (—26) μ long, 13—16 (—19) μ broad.

Under this species I have included two forms regarded by KYLIN as distinct species, namely *Ch. virgatula* and *Ch. luxurians*, because I have not been able to distinguish them after the alleged characters. In most of the Danish specimens the thickness of the filaments varies between 11 and 13 μ , thus within the limits indicated for *Ch. luxurians* by KYLIN, and the dimensions of the sporangia also agree with the measurements indicated for this species. On the other hand, the specimens with thicker filaments, thus agreeing better with *Ch. virgatula* KYLIN, had not shorter, approximately globular sporangia as indicated by KYLIN, but were of the same dimensions. The thickest filaments were found in some specimens from Lysegrund in Ks (9,5 meters); they varied from 13 to 20 μ in thickness, the cells were thick-

walled, 3 to 4 times as long as broad, the sporangia $17.5\text{--}19\ \mu$ long, $14\text{--}15$ (16) μ broad. As a contrast to these some specimens may be mentioned which were found growing on *Porphyra umbilicalis* in Thyborøn Channel (Lf); they agreed on the whole fairly well with this form, but the filaments were only $7\text{--}8\ \mu$ thick. Such a small thickness I have otherwise never observed in the specimens referred to this form, though certainly in *f. secundata* which occurs along the west coast of Jutland; I imagine that these specimens may have originated from *f. secundata* but have developed in a more sheltered locality. It deserves notice that groin no. 63 is more sheltered than no. 62 where *f. secundata* was found growing, and that the species has otherwise not been found in the Limfjord with the exception of at Hals at the eastern entrance of the fjord where *f. secundata* has been met with. — For the rest the specimens referred to this form are on the whole homogenous.

This form has been found in all the Danish waters within Skagen, from low-water mark to 11.5 meters depth. The specimens found at Bornholm are typical but not very vigorous and with little branched filaments. It was mostly met with in the summer months and is undoubtedly mainly a summer Alga; for the rest it has been met with in the months April to November, in all cases with sporangia. It was most frequently found growing on *Polysiphonia violacea* and *nigrescens*, further on *Ceramium rubrum* a. o. species, *Cystoclonium*, *Zostera*-leaves, *Porphyra umbilicalis* and *Sertularia pumila*.

Localities. Lf: Thyborøn Channel, groin no. 63, otherwise not found in the Limfjord. — Kn: Harbour of Skagen; Hirsholm; Frederikshavn (Th. Mortensen, !); Nordre Rønner; stony reef by Jegens Odde (GM). — Ks: Lysegrund; D, 11.5 meters. — Sa: Rønne in Begtrup Vig; Kalø Rev; AS, Mejlgrund. — Lb: Fæno. — Sb: Kertinge Vig. — Sm: Petersværft; Guldborgsund. — Su: BQ, off Ellekilde; Helsingør; Copenhagen. — Bm: QP, Kalkgrund; QR, Gyldenløves Flak. — Bb: Rønne; off Allinge.

β, tetrica nob.

Filaments (8—) 9—12 μ thick, cells 2—4 diameters long, sporangia on opposite branchlets or sessile on the long filaments, all or partly tetrasporous and then 19—22 μ long, 13—17 μ broad.



Fig. 38.

Chantrelaria virgatula *β, tetrica*. A, B and C, young plants seen from above and from the side. D, branched filament with tetrasporangia mostly on opposite branchlets. E, filament with sessile tetrasporangia. F, two cells showing the chromatophore. 265:1.

The above diagnosis is made after specimens growing on *Porphyra umbilicalis* in the harbours of Skagen and Frederikshavn. They are somewhat more branched than *f. luxurians* and have a little thinner filaments and shorter cells. The sporangia are very numerous and, at least in many specimens, all tetrasporous. They are in a great measure placed on branchlets which are usually opposite, partly also sessile on the sides of the filaments. From the characters mentioned this form is, in spite of its great resemblance, so different from the main form, that I

was for some time inclined to regard it as a distinct species, but some other less pronounced specimens have led me to the result that it is closely related to the *f. luxurians* and still more to the *f. secundata*. Thus I found at Middelfart some specimens having chiefly monosporangia, 16—20 μ long, 11—13 μ broad, but also some tetrasporangia, and the sporangia were placed on the filaments as well as on the branchlets. These specimens might be regarded as intermediate between *f. luxurians* and *f. tetrica*, but they were also related to *f. secundata*, differing however by longer cells (3—5 diameters long). The resemblance between the *f. tetrica* and *f. secundata* will be seen on comparing fig. 38 with fig. 39. To this form at least some of the Færoese specimens mentioned by BØRGESSEN (l. c. fig. 53) may be referred.

Only found in summer, the typical specimens growing on *Porphyra umbilicalis*.

Localities. **Kn**: Harbours of Skagen and Frederikshavn. — **Sa**: Middelfart, on *Cladophora*.

γ, secundata (Lyngb.).

Callithamnion Dawiesii β, secundatum Lyngb. Hydr. p. 129 tab. 41.

Acrochaetium secundatum Næg. Beitr. Ceram. p. 405.

Chantransia secundata Thur. in Le Jol. Liste p. 106;

BØRGESSEN, M. A. Fær. p. 350; KUCKUCK in OLTMANNS,

Morph. Alg. I p. 650; KYLIN (1907) p. 115.

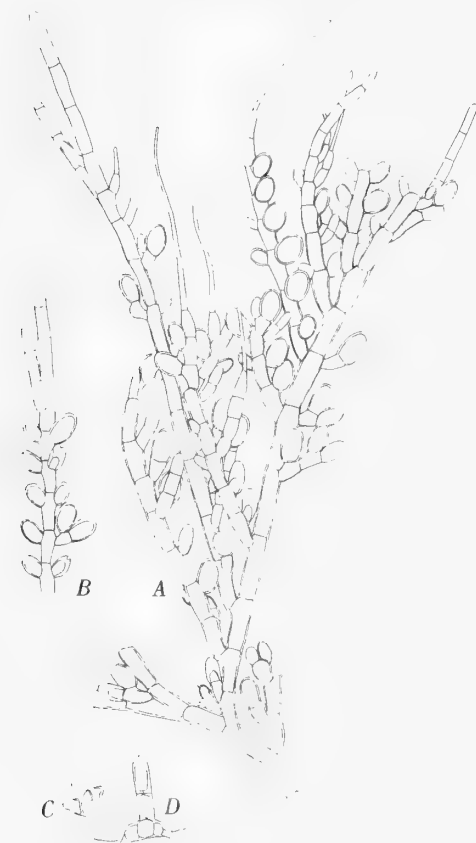


Fig. 39.

Chantransia virgatula γ, secundata. Plants growing on *Porphyra umbilicalis* at Eshjerg. A and B, branched filaments with monosporangia. C and D, young plants. 260:1.

That *Ch. virgatula* and *Ch. secundata* are nearly related and often difficult to distinguish from each other has often been admitted, also by BØRGESSEN and KUCKUCK, who think however that for the present they ought be kept distinct (BØRGESSEN l. c. p. 354). I have also wished to regard *Ch. secundata* as a distinct species, but I have ended by referring it as a form to *Ch. virgatula*, as the limit between them, according to my experience, cannot be drawn without arbitrariness. As mentioned above,

tetrasporangia have been found together with monosporangia by earlier authors in this form; I have found the same in Danish specimens in some few cases, but I was then usually in doubt whether the specimens ought to be referred to this or

to the foregoing form. They pass really, in my experience, gradually into each other.

The filaments are much branched, more than in *f. luxurians*, often very much branched, and the branches are then usually lying in one plane, being second or opposite. There is no distinction between branches and branchlets. The filaments are 7–12 (—14) μ thick, the cells 1–3 times as long as broad. The sporangia are nearly always

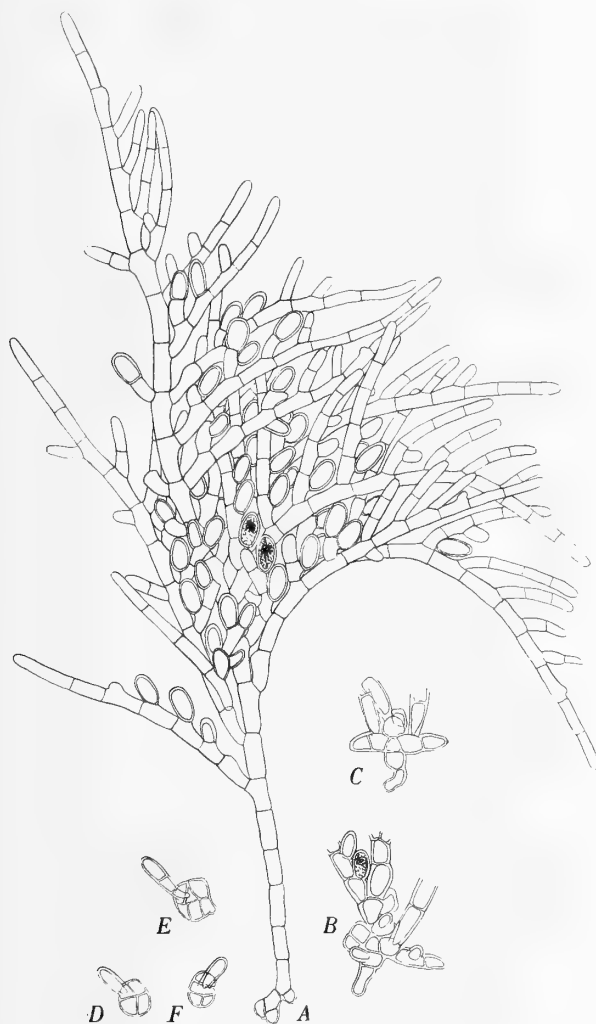


Fig. 40.

Chantransia virgatula γ , *secundata*. Plants growing on *Porphyra umbilicalis* at Thyborøn. A, much branched plant with monosporangia. B and C, basal portions of plants. D–F, young plants seen from above. 260:1.



Fig. 41.

Chantransia virgatula γ , *secundata*. Plants growing on *Porphyra umbilicalis* at Thyborøn. A, young plant. B, plant with monosporangia. 260:1.

monosporous, (13—) 15–20 (—21) μ long, (9—) 10–14 (—15) μ broad. They are sessile on the sides of the filaments or terminal and lateral on the branchlets. The sporangia as well as the sporangia-bearing branches are often second, and then situated on the upper, inner side of the branches (fig. 40 A), but they may also be opposite or at least situated two on the same cell (figs. 39, 41). The basal layer is

sometimes proportionally much developed (fig. 41), but like KYLIN I found it always consisting of one layer of cells, while PRINGSHEIM (Beitr. Morph. Meeresalg. p. 26 Taf. VII fig. 2), BØRGESEN and COLLINS (1906 p. 194) found it consisting of two or several layers.

While this form in its typical shape is quite distinct from the typical f. *luxurians*, intermediate specimens may sometimes occur. In my opinion it is a reduced form of the species produced by growing near the low-water mark, where it may sometimes be exposed to the air. On the Danish shores it has only been found at the low-water mark, on the west coast of Jutland even at a higher level. It has been found growing on *Porphyra umbilicalis*, *Sertularia pumila*, *Chætomorpha Melagonium* and *Polysiphonia nigrescens*, in the months January to August.

Localities. Ns: Esbjerg; groin no. 62 by Thyborøn. — Sk: Hirshals mole. — Lf: Hals. — Kn: Frederikshavn, harbour (1, TH. MORTENSEN, C. H. OSTENFELD).

11. *Chantransia Macula* sp. nov.

Thallus minutus membranaceus monostromaticus fere orbicularis, diametro usque c. 70 μ , substrato adhaerens, initio parenchymaticus; dissepimentum primum medianum, sequentia obliqua; postea cellulæ marginales in fila repentia plus minus radiantia excrescunt. Cellulæ c. 4 μ crassæ, diametro sesqui- ad duplo longiores, chromatophorum stellare pyrenoide centrali instructum continent. Fila erecta sparsa brevissima paucicellularia simplicia plerumque e disco egrediuntur. Pili hyalini in filis radiantibus erectisque terminales hinc illinc occurrunt. Sporangia monospora in disco sessilia vel in filis erectis terminalia, ovata, long. 10—11,5 μ , lat. 6,5—7 μ .

This very small species has been found growing on *Polysiphonia violacea* together with several other species of *Chantransia*. It is very characteristic from its thin disc-shaped frond of an irregular outline, approaching however the circular, and corresponding to the basal layer of the more developed species, while the erect filaments are wanting or much reduced. The germinating spore divides always by a median vertical wall, and oblique walls then appear in the two daughter-cells, frequently resulting in the formation of two inner, triangular and four outer cells (fig. 42 A, B, F). The orientation of the walls may be somewhat variable, but in the central part of the more developed discs one or two triangular cells are usually recognizable, thus indicating the place of the first division wall. In some cases one of the primary daughter-cells only is divided by oblique walls (fig. 42 D), and more rarely both cells are divided by a wall parallel to the first. The plant keeps for some time its parenchymatous character and a fairly regular outline, often up to the eight-celled stage, but then the marginal cells begin to grow out into creeping filaments which from the first may be rather irregular but later by the increasing number become more regularly radiating, forming a pseudoparenchymatous disc with irregular border formed by the separate ends of the filaments. The

filaments branch laterally from the subterminal cells or by subdichotomous division of the terminal cell (fig. 42 H). The cells are somewhat various in shape, usually longer than broad, and contain a stellate chromatophore with central pyrenoid which is usually situated in the median line of the cell, sometimes however nearer to the one side of the cell. The hairs appear in various quantity, sometimes already in the parenchymatous stage (fig. 42 A). The erect filaments, if they are not entirely wanting, appear in rather small number spread on the disc; I have found them one to three cells long, scarcely 4μ thick. The sporangia are placed directly on the basal disc or terminal on the erect filaments; they were not very numerous in the specimens examined.

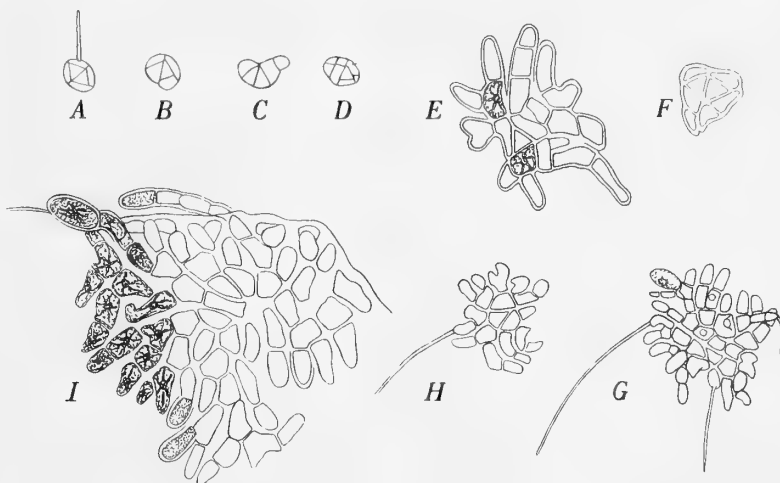


Fig. 42.

Chantransia Macula. A—D, young plants in the parenchymatous stage. E, older plant, with marginal cells growing out into filaments. F, parenchymatous disc. G—I, more developed discs, partly with erect filaments and sporangia. A—E from BH, F—I from AH¹. A—D, G—H 390:1; E, F, I 630:1.

The species is easily distinguishable from all other species by the characteristic disc and the position of the sporangia. It has been found in August and September in depths of 7,5 to 11,5 meters.

Localities. **Km**: BH off Gjerrild Klint. — **Sa**: AH¹ by Fyens Hoved; MQ, S. of Samsø.

12. *Chantransia polyblasta* sp. nov.

Thallus cæspitosus. Pars basalis e filis repentibus, ramosis, initio saltem inter se discretis, constructa. Spora germinans dissepimento verticali diametrali in duas cellulas aequales dividitur, quarum utraque filum repens procreat. E filo primario lateraliter fila repentina et sursum fila erecta numerosa per totam longitudinem egrediuntur. Fila erecta usque ad c. 270μ longa, maxima ex parte brevia, longiora ramosa, ramis ramulisque numerosis in quoque articulo singula vel bina, ramis majoribus eodem modo ramosis. Pili hyalini apicibus filorum et ramulorum impositi occurrunt. Cellulæ 7—10 μ crassæ, diametro 2—3 (—4)-plo longiores, chromatophorum stelliforme, pyrenoide centrali instructum, continentes. Sporangia tetraspora, ovata, (16—) 18—21 μ longa, 10—12 μ lata, in filis erectis primariis vel in ramis lateralibus vel terminalibus, lateralibus sessilibus vel in ramulis unicellularibus vulgo singula.

In its mode of growth this species resembles the species *Ch. Dumontiae* and *Ch. cytophaga* described below. The germinating spore divides, as in these, into two equal cells giving rise to two creeping filaments growing out in opposite directions and giving off new creeping filaments which appear to be later confluent into a pseudoparenchymatous disc in the central part of the basal layer. Usually one erect filament is given off from each of the cells of the basal layer, the outer

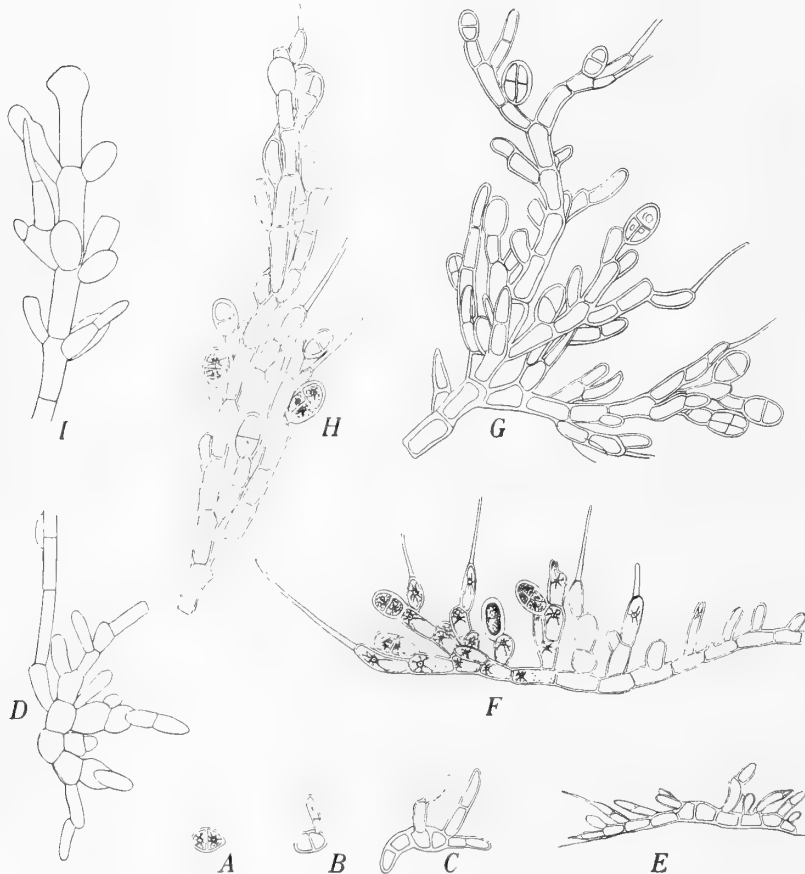


Fig. 43.]

Chantransia polyblasta. (From Hals). A—C, young plants seen from above. D, more developed plant seen from above. E, F, plants seen from the side with short erect filaments. G, H, more developed, branched erect filaments, I, end of erect filament. A—C, E—H 300:1, D, I 390:1.

as well as the inner, and not rarely the same cell gives off two filaments, the one behind the other (fig. 43 E, F). Most of the filaments attain only a small size and remain unbranched, but some of them grow out and become much branched. The most vigorous filaments are much and repeatedly branched; usually each cell bears one or two branches, long filaments or branchlets, but there is no distinction between these two kinds of branches, as transitions between them frequently occur. When two branches are borne by the same cell, they are very often not opposite but placed near each other on the same side of the cell. In fig. 43 E, F the last cell of the creeping filament is seen to be somewhat raised above the substratum and ends in a hair. Transitions between creeping and erect filaments thus appear to occur; however, I have never seen the transformation of a creeping filament into a true erect one. The cells are cylindrical, by ramification frequently a little broader at the upper end. The stellate chromatophore contains a distinct central pyrenoid.

When two branches are borne by the same cell, they are very often not oppo-

The sporangia are very often sessile on the sides of the filaments; the same cell then also bears frequently a branch or a branchlet, or it may bear up to four lateral organs (fig. 43 *I*). But the sporangia may also be terminal on the filaments or on one-celled branchlets. It also sometimes happens that the sporangia are produced directly by the creeping filaments. The sporangia are always tetrasporous; monosporangia were never observed.

As mentioned above, the mode of growth somewhat resembles that of *Ch. Dumontiæ*; it differs mainly by being throughout epiphytic. In examining numerous sections of *Cystoclonium* covered with *Ch. polyblasta*, I have once only seen a creeping filament penetrating through the surface of the host, but the surface was there evidently injured. As another difference may be named that the chromatophores have a distinct pyrenoid in *Ch. polyblasta* while such a body is not to be found in *Ch. Dumontiæ*. As to its relation to *Ch. humilis* see this species.

The species has been found in spring (April, May) in two localities in the northern Kattegat and at Hals at the eastern entrance to the Limfjord. It occurred in greatest quantity in the last named locality, where it was found growing on *Cystoclonium purpurascens*, collected by Dr. BØRGESEN; in the other localities it was growing on *Polysiphonia nigrescens*.

Localities. **Lf**: Harbour of Hals (Børgesen). — **Kn**: Krageskovs Rev, 4—5,5 meters; harbour of Frederikshavn (Børgesen).

13. *Chantransia humilis* sp. nov.

Thallus pulvinatus. Pars basalis e filis repentibus ramosis breviarticulatis in parte centrali demum confluentibus, constructa. Spora germinans in duas cellulas æquales divisa est, quarum utraque filum repens procreat. E filis primariis lateraliter fila repentia et superne fila erecta numerosa per totam longitudinem, e quaque cellula 2—3, egrediuntur. Fila erecta brevia, 2—4-cellularia, c. 60 μ alta, simplicia; cellulæ apicem versus sensim incrassatæ, superne 5,5—7 μ crassæ, diametro 2—3-plo longiores, chromatophorum axile, pyrenoide centrali instructum continentes. Pili hyalini apicales crebri. Sporangia monospora ovata vel oblonga, long. 11—14 μ , lat. 7 μ , in filis erectis terminalia vel lateralita.

In its mode of growth and the structure of the cells this species somewhat resembles *Ch. polyblasta*, from which it differs however by its short, unbranched, erect filaments and by the smaller, monosporous sporangia. The basal layer develops as in the species named; as shown in fig. 44 *D*, the germinating spore is nearly globular, much higher than the primary creeping filaments, and the two primary cells are for a long time recognizable from the other cells in the basal layer. In fully developed plants the creeping filaments are more or less confluent in the inner part of the plant; the cells are there usually short, roundish, 7—9 μ broad. The formation of the erect filaments begins as a rule when the basal layer is two-celled (fig. 45) but I have in some cases seen an erect filament given off from a basal cell still undivided. Hyaline hairs frequently occur at the end of the

erect filaments, more rarely at the sides of them. It appears that the usual displacement of the originally terminal hairs occurs also in this species, but that the hairs soon disappear; the fact that the upper end of the cells is usually prominent at one side is in accordance with this supposition. The hairs may appear already in the two-celled stage of the plants (fig. 44 C). The erect filaments seem to be always unbranched; their great number in conjunction with their small size give the plant a pulvinate appearance. The cells of the erect and creeping filaments,

as well as the sporangia, contain a stellate chromatophore giving off a number of branches towards the periphery. The species has hitherto only been found in one locality, growing on *Polysiphonia nigrescens* in May.

Locality. Sb: pier at Spodsbjerg, Langeland.

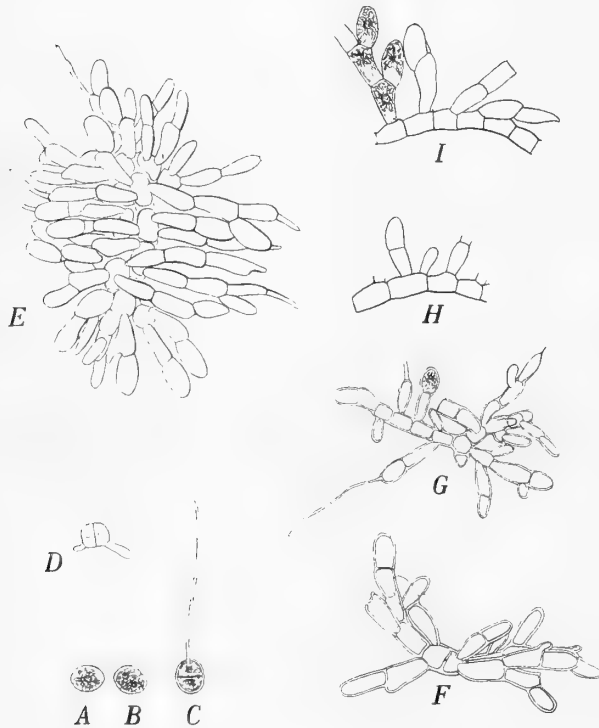


Fig. 44.

Chantransia humilis. A—C. germinating plants, C with a hair. D, the two first creeping filaments are given off: the pyrenoids are shown. E, adult plant seen from above. F, G, plants seen from above, G with sporangium. H, I, plants seen in vertical section, I with lateral sporangium. A—F, H, I 300:1. G 300:1.

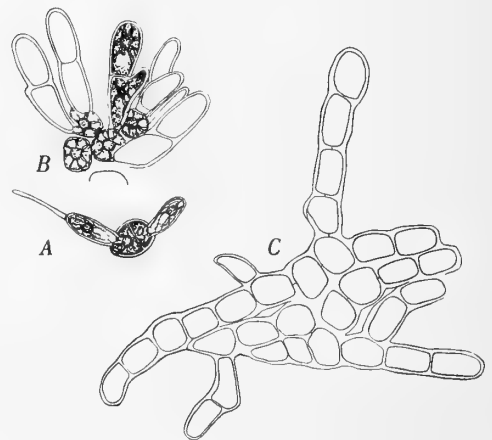


Fig. 45.

Chantransia humilis. A, young plant, seen from above. B, part of a plant showing the basal layer and erect filaments with terminal sporangia. C, basal layer seen from below. 560:1.

14. *Chantransia leptonema* sp. nov.

Thallus minutus e filis repentibus et filis erectis numerosis constructus. Fila repentia irregularia, lateraliter ramosa, plerumque ut videtur inter se libera, cellulis plus minus tumidis, lat. 3—4 μ , diametro sesqui- ad triplo longioribus. Spora germinans discum parenchymaticum serius in fila repentia excrecentem gignit. Fila erecta simplicia vel parce ramosa, usque ad 300 μ longa, 3—4 μ lata, cellulis diametro duplo ad 5-plo longioribus, cylindraceis vel, in cellulis brevibus, leviter tumidis, chromatophorum cylindraceum pyrenoide centrali munitum continentibus.

Pili hyalini terminales occurrunt. Sporangia monospora (et tetraspora?) in filis primi et secundi ordinis lateralia vel terminalia, plerumque sparsa, unilateraliter seriata, rarius opposita, nonnunquam in ramulis unicellularibus bina vel solitaria, etiam in filis repentibus sessilia, ovata, long. 10—12,5 μ , lat. 5,5—6,5 μ .

The above diagnosis is essentially made after specimens growing on *Chondrus crispus* found at Hanstholm, on which it formed a fine felted covering. One erect filament is usually given off from each cell in the creeping filaments, except the outermost ones. In the most developed erect filaments the cells are cylindrical, usually 3—4 diameters long (up to 17 μ long), while in shorter filaments and in the fructiferous parts of the longer the cells are shorter and often somewhat swollen. The shape of the chromatophore was not easily discernible, as I had only dried material at my disposal; in some cases, however, a chromatophore was visible, consisting of a cylindrical parietal plate and an axile part containing a central

pyrenoid lying in the upper part of the cell (fig. 47 A). Most of the erect filaments attain only a small size and remain unbranched, but some grow longer and may

then bear one or some few vegetative branches. Terminal hairs frequently occur and may give rise to sympodial branching. The sporangia are in great measure lateral on the erect filaments and then as a rule seriate, a position which often causes a recurvation of the filament (fig. 46 A, G). The sporangia are more rarely opposite, but they are frequently terminal, in the long filaments as well as in the very short (figs. 46, 47);

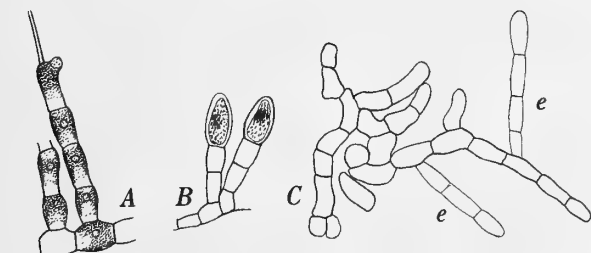


Fig. 47.

Chantransia leptoneima (Hanstholm). A and B, fragments of creeping filaments with short erect filaments. C, creeping filaments seen from below and two erect filaments, e. 620:1.

in the specimens from Hanstholm sporangia sitting directly on the creeping filaments were not observed. Sporangia borne on unicellular branchlets also occur, one sporangium being terminal, the other lateral (fig. 46 B, C). The long filaments are only sporangia-bearing in their upper part. The sporangia are only a little varying in shape and size, nearly twice as long as broad. They appear to be

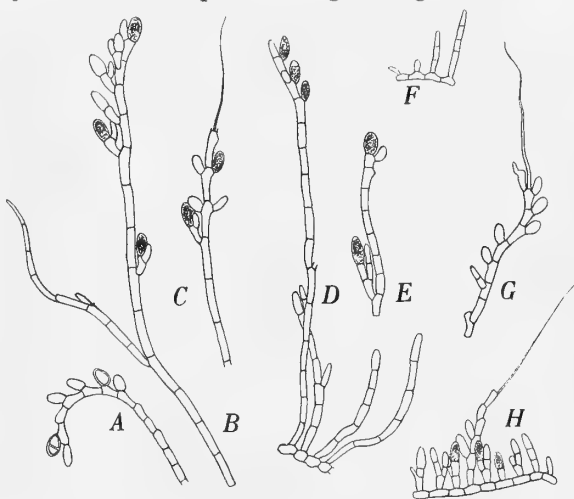


Fig. 46.

Chantransia leptoneima (Hanstholm). A—C, E, G, erect filaments with sporangia. D, F, H, creeping filaments with erect filaments. 300:1.

usually monosporous; in some cases, however, the contents seemed to be divided into two or four parts (fig. 46 A), but conclusive observations were not arrived at.

On *Polysiphonia urceolata* dredged near Hirshals I have found, growing in company with other interesting Algæ (*Erythrocladia irregularis* and *subcontinua*, *Chantransia emergens*), a small *Chantransia* which I believed at first to be a different species, most of the rather few specimens consisting only of creeping filaments, bearing sporangia either directly or on unicellular stalks (fig. 48). Later however I found other specimens with numerous erect, partly sporangia-bearing filaments fully agreeing with the above described specimens growing on *Chondrus*, and I therefore have no doubt that they belong to the same species. The dimensions were the same; I found however that the sporangia borne directly on the basal layer were somewhat shorter, 8–9 μ long, 6 μ broad, perhaps only because they were not fully

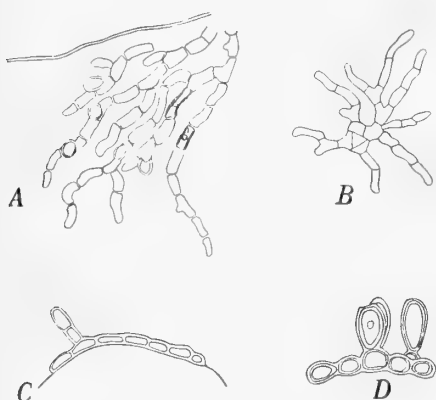


Fig. 48.

Chantransia leptomena. (From XO). A, creeping filaments on the surface of *Polysiphonia urceolata*, bearing sporangia. B, fairly young plant seen from above. C and D, plants seen in vertical section, D with sporangia. A–C 390:1. D, 730:1.

ripe. The chromatophore showed the same appearance as in the specimens from Hanstholm, but the pyrenoid appeared not to be central; as the material from both localities was only dried, the question must however be left open. In some fairly juvenile plants I succeeded in finding that the first divisions of the germinating spore take place in a similar manner as in *Ch. virgatula*, three peripheral cells being cut off round an inner triangular cell (fig. 48 B).

This species appears to be distinct from all hitherto described species especially by its mode of growth and its slight thickness. *Ch. chiloensis* Reinsch (Contrib. ad Alg. et Fung. Vol. I 1877 p. 37 Taf. XI fig. 1) which was found at St. Thomas, West Indies, growing on *Acanthophora Thierii*, differs according to REINSCH by the greater length

and thickness of the filaments, by the short creeping filaments consisting of shorter cells and by broader sporangia.

Localities. Sk: Hanstholm, Roshage, on *Chondrus crispus* in 2 m. depth, YU⁴, August; XO, Møllegrund off Hirshals, on *Polysiphonia urceolata*, 11,5 to 15 m., August.

15. *Chantransia reducta* sp. nov.

Thallus filiformis ramosus repens substrato affixus. Spora germinans in cellulas duas divisa est quarum utraque filum repens procreat. Cellulæ filorum repentium leviter tumidæ, c. 4 μ crassæ, longitudine diametro fere æquali vel sæpius duplo longiores, chromatophorum parietale, pyrenoide fere axili munitum, continentes; utraque cellula demum superne sporangium aut filum brevissimum gerens. Fila erecta 1–3-cellularia simplicia, rarissime ramosa, 4,5–6 μ lata, cellulis diametro fere æquilongis vel paullo longioribus, nonnunquam pilum hyalinum apicalem

brevem gerentia. Sporangia monospora in filis repentibus sessilia aut in filis erectis terminalia, ovata vel subsphærica, long. 7—9,5 μ , lat. 5,5—7,5 μ .

The erect filaments are extremely reduced in this species; only in *Ch. Macula* among the epiphytic species here mentioned are they as much reduced. In most cases the reduction process is carried so far that the erect filament has completely disappeared, and the sporangium is situated directly on the creeping filament, or it is represented by a single stalk-cell. The erect filaments, however, may be sometimes two- or three-celled, and I have, though very rarely, seen such filaments bearing a unicellular branch (fig. 49 C). In hardened material a parietal chromatophore with a large pyrenoid was easily visible; the latter were apparently lying in the median line of the cell, but were, in some cases at least, certainly excentric (fig. 49 A, B). The two cells resulting from the division of the germinating spore remain easily recognizable by their greater breadth and rounded outline (fig. 49 A, G, H, I). In this mode of germination the species recalls *Ch. humilis* (p. 117) which has also little developed erect filaments, but this species differs by its greater dimensions, by two or three erect filaments given off from each cell in the basal layer, and by stellate chromatophores. The *Ch. leptonema* just described may also occur in a much reduced form resembling *Ch. reducta*; but that form differs by a different mode of division of the germinating spore (fig. 48).

The species has been found growing on *Polysiphonia nigrescens* and *Rhodomela subfusca* collected near the low-water mark in the northern Kattegat, in July and September.

Localities. **Kn**: Hirsholm; harbour of Frederikshavn; dry rock near Jegens Odde (GM).

Group III. Frond partly or entirely endophytic.

16. *Chantransia cytophaga* sp. nov.

Thallus cæspitosus, ad 0,2 mm. altus, e filis 1^o repentibus plantæ hospiti affixis, 2^o erectis sporangiferis et 3^o endophyticis constructus. Spora germinans dissepimento verticali in duas cellulas divisa est quarum utraque filum horizontale

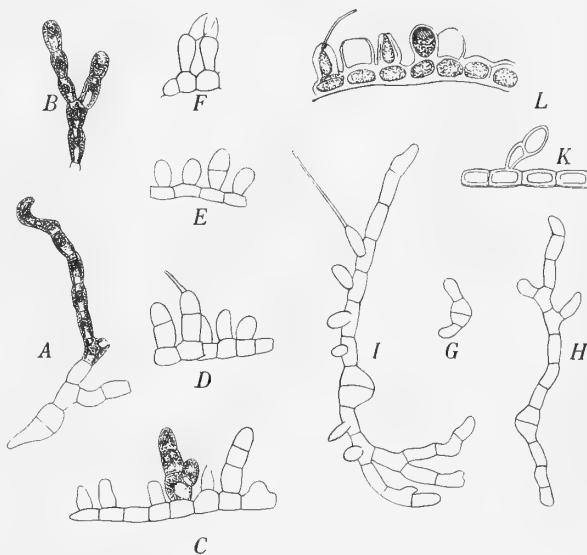


Fig. 49.

Chantransia reducta. A and B (Frederikshavn), creeping filaments showing the chromatophores. C—F, plants in vertical section with sporangia. G, young plant seen from above. H, more developed plant seen from the under side. I, plant seen from above. K, fragment of plant in vertical section, with a stalked sporangium. L, fragment of plant with sessile sporangia, in vertical section. C—L from GM. 560:1.

procreat. E filis primariis lateraliter fila repentia, subtus fila endophytica et superne fila erecta numerosa egrediuntur. Fila endophytica breviter ramosa, in cellulas hospitis penetrantes. Fila erecta simplicia vel parce ramosa, 7–10 μ lata, apicem versus paullo attenuata. Cellulae diametro fere duplo longiores, superne vel medio tumidae, chromatophorum stelliforme, ut videtur sine pyrenoide, in parte superiori

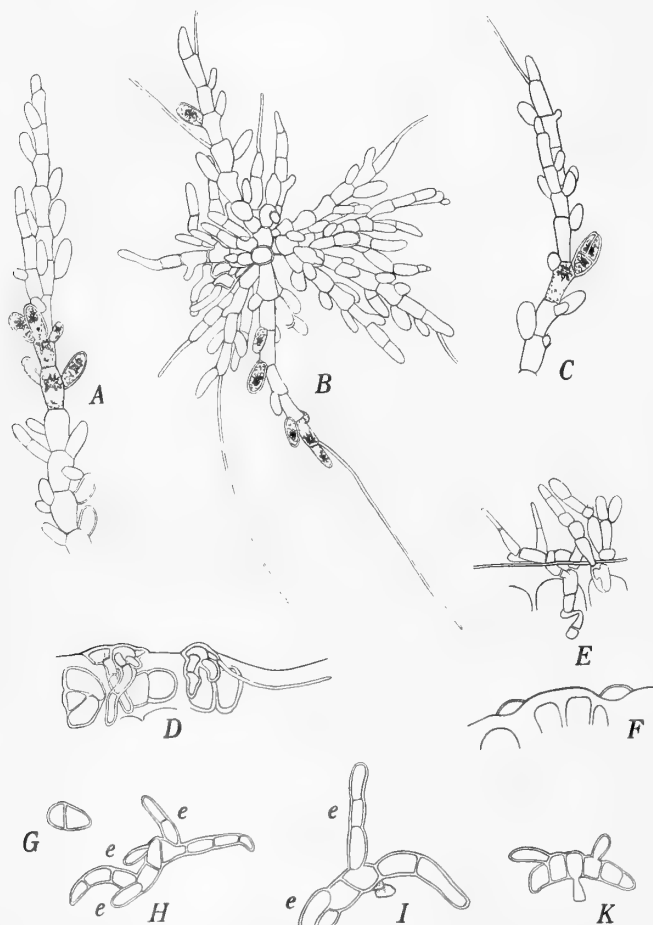


Fig. 50.

Chantransia cytophaga. A, Filament with monosporangia. B, plant seen from above. C, filament with tetrasporangium. D, young plants fastened to the margin of the frond of *Porphyra*. E, transverse section of *Porphyra* with the parasite. F, two spores on the point of germinating on the margin of the *Porphyra*. G, two-celled plant. H, more developed plant with three erect filaments, e. I and K, plants with two erect filaments and haustorium. A–G 300:1. H–K 400:1.

cellulae situm continentes. Pili hyalini adsunt. Sporangia in filis lateralibus, sessilia, in utroque articulo plerumque 2–3, monospora aut tetraspora, ovata vel ellipsoidea, latitudine fere duplo longiora, monospora (11–) 13–17 μ longa, 7,5–8 μ lata, tetraspora c. 19 μ longa, 10 μ lata.

This species forms small cushions on the margin and at a small distance from the margin of the frond of *Porphyra umbilicalis*. It reminds one in its mode of growth as well as in other respects of *Ch. Dumontiae* but is smaller. The basal layer develops as in *Ch. polyblasta* and *Ch. humilis* and finally consists of filaments radiating on all sides though often rather irregularly, and it sometimes happens that one filament is growing over another (fig. 50 D). When the *Chantransia* is situated on the margin of the *Porphyra*, the filaments make their way on both sides of the flat frond. From some of the cells in these filaments are given off haustorial filaments penetrating into the host. The place of the endophytic filaments is

indistinct, but they appear to be mainly given off from the central part of the basal layer. They make their way through the outer wall of the host and penetrate into the nearest cell, the protoplasm of which is more or less displaced by the intruding haustorium (fig. 51). As shown in fig. 51 A two haustoria may some-

times penetrate into one cell. The filaments often branch within the host cell, and some of the branches may again become free, growing outwards through the wall of the host, and the same occurs with endophytic filaments without branching (in fig. 51 the free endings of the haustorial filaments are not shaded). As far as I have observed, these filaments do not penetrate from one cell into another, and therefore do not serve as propagating organs. The protoplasm of the host cell is more or less shrunk and evidently yields nourishment to the *Chantransia* which is thus a veritable parasite.

A great number of erect filaments are given off from the creeping filaments, from the peripheral part as well as the central. As new erect filaments are constantly produced, a fully developed plant shows numerous erect filaments of different sizes, giving the plant a cushion-shaped appearance. Most of these filaments attain only an inconsiderable length, the greatest are about 200 μ long; they are either unbranched or bear one or a few branches which are much shorter than the main filament. Hyaline hairs frequently occur at the ends of the filaments, becoming lateral by the continued growth of these. In the lower part of the filaments the cells are more or less swollen at their upper ends or in the middle. The structure of the cell is the same as in *Ch. Dumontiae* (see p. 124), the chromatophore being stellate without pyrenoid, while a body staining intensely by hæmalum and undoubtedly a nucleus is to be seen under the chromatophore.

The sporangia are always sessile on the sides of the erect filaments, in their whole length. From the first each cell bears one sporangium, but very soon one or two others appear, and each cell bears thus usually two or three sporangia, the two being as a rule opposite. The latest formed sporangium is sometimes seated at a lower level than the other, near the middle of the cell. Terminal sporangia were not observed. Nearly all the sporangia were monosporous, very few tetrasporous; the latter were somewhat larger than the other. Possibly some of the undivided sporangia were unripe tetrasporangia; I imagine, however, that most of them were really monosporangia.

The structure of the cell and the mode of growth bring this species near to *Ch. Dumontiae*; it differs from it in particular by the intracellular haustoria, by shorter, less branched erect filaments, by shorter cells and by the want of terminal

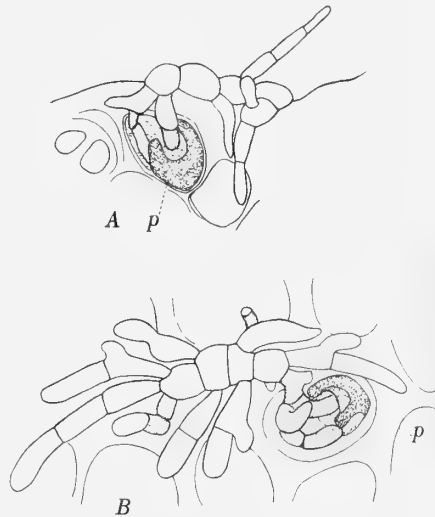


Fig. 51.

Chantransia cytophaga. A, plant growing on the margin of the frond of *Porphyra umbilicalis*, to the left two haustoria penetrating into the same cell. B, plant growing on the flat side of the frond seen from above, showing three haustorial filaments. The endophytic filaments are shaded, their free emerging ends are white; p, protoplasm of the host cell. 550:1.

sporangia. *Ch. polyblasta* and *Ch. humilis* differ by the want of endophytic filaments and by the presence of a distinct pyrenoid.

Locality. **Su:** Only found at Helsingør, growing on *Porphyra umbilicalis* on the outer side of the southern mole in September.

17. *Chantransia Dumontiae* sp. nov.

Thallus cæspitosus ad 0,5 mm. altus, e filis 1^o horizontalibus epiphyticis 2^o erectis ramosis sporangiferis et 3^o endophyticis constructus. Spora germinans dissepimento verticali diametrali in duas cellulas æquales divisa est quarum utraque filum horizontale procreat. E filis primariis lateraliter fila repentia et superne fila erecta egrediuntur. Fila endophytica intercellularia ex parte saltem e filis erectis egrediuntur. Fila erecta a basi ramosa, ramis numerosis sparsis plus minus ramosis; cellulæ diametro fere triplo longiores, superne 6,5—9 μ crassæ, inferne tenuiores, chromatophorum stellare, ut videtur sine pyrenoide, in parte superiori cellulæ situm continentes. Pili hyalini terminales vel pseudolaterales adsunt. Sporangia tetraspora oblonga—ovata, latitudine fere duplo longiora, 15—19 μ longa, 8—11 μ lata, in filis lateralibus et terminalibus, plerumque sessilia, sparsa vel opposita, nonnunquam in ramulis unicellularibus singula vel bina.

The species forms numerous small, dark-purple tufts or cushions on fronds of *Dumontia filiformis*. They consist of numerous erect branched filaments given off from the creeping filaments, partly also from the endophytic threads. The germination takes place as in *Ch. cytophaga* and others of the above described species (fig. 52 A, B). The epiphytic creeping filaments are often somewhat irregular, thick and short-celled, and, as shown in fig. E, they are not always densely attached to the surface of the host. I am not able to say if the first endophytic filaments are given off from the underside of the creeping filaments or not. At all events endophytic filaments are also given off from the base of the erect filaments (fig. D). The endophytic filaments are much branched growing intercellularly in the host, and free erect filaments may again be given off from them through the surface of the frond. I believe that this may take place also at a greater distance from the point of departure of the endophytic filaments, these thus serving to propagate the *Chantransia* in the host. The free filament shown in fig. D has probably emerged from the endophytic one. It appears that relatively few endophytic filaments are given off in the same cushion.

The erect filaments arise in great number from the creeping filaments, from their peripheral as well as their central parts, and the plant forms therefore tufts or cushions of $\frac{1}{2}$ —1 mm. in diameter. These filaments are fairly strongly branched, as a rule from the base, and often a branch is given off from each cell in a great part of the primary filaments, and the branches may also be branched. The cells are usually broader at the upper end than below, depending on the abundant ramification. In the central part of the stellate chromatophore I was not able to detect any pyrenoid staining stronger with hæmalum than the remaining substance

of the chromatophore, while the nucleus, lying under the chromatophore but near the periphery of the cell, more rarely at the same level as the chromatophore, was very intensely stained by this reagent.

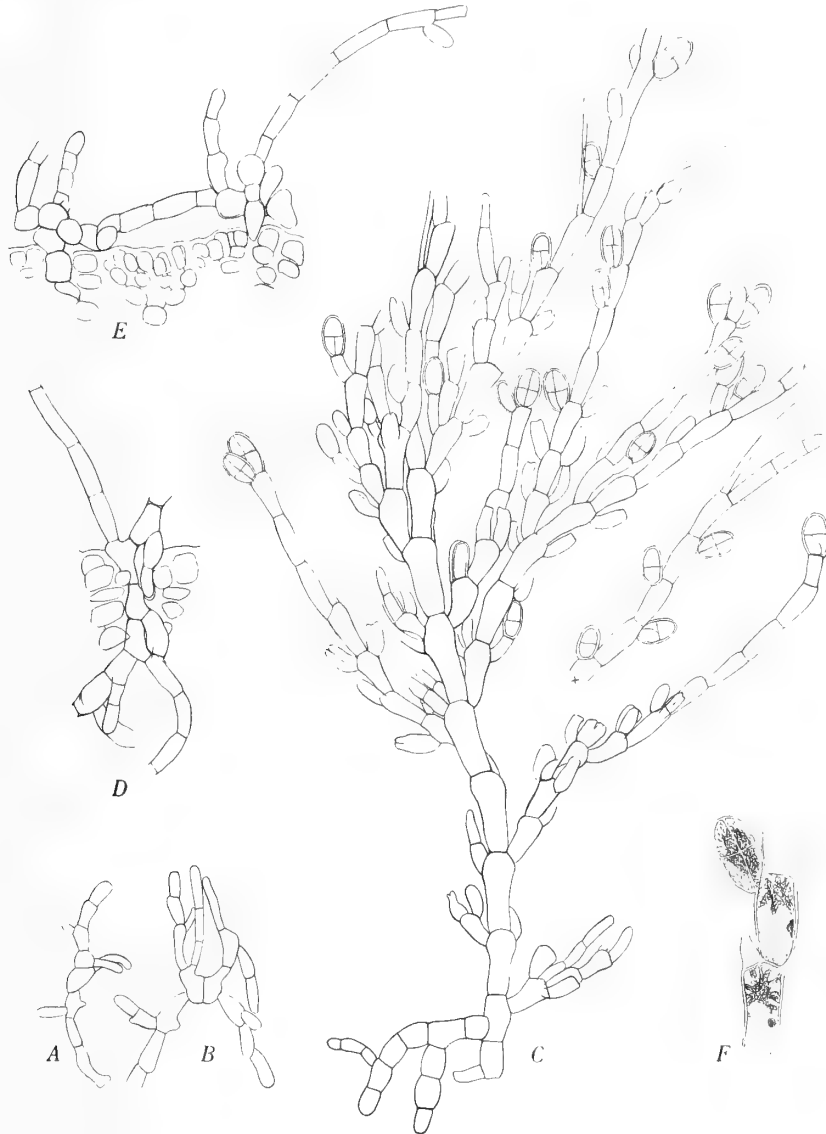


Fig. 52.

Chantransia Dumontiei. A and B, young plants seen from above. C, plant with tetrasporangia, below horizontal and descending filaments. D and E, transverse sections of *Dumontia* with *Chantransia*, showing endophytic, horizontal and erect filaments of the latter. F, two cells and a sporangium, the cells showing chromatophore and nucleus. A—E 390:1, F 550:1.

The sporangia are most frequently sessile on the sides of the filaments, or they are placed on unicellular branchlets singly or two together, or lastly they

may be terminal on the long branches. From the first the cells bear usually only one sporangium or a sporangium-bearing branchlet, but later further sporangia may develop so that a great number of the cells bear two or three sporangia. When two sporangia occur, they may be opposite or near to each other, but a sporangium may also be placed under another sporangium or under a branch (fig. C). The cells giving off a branch bear frequently a sporangium opposite to it. Mono-sporangia were not observed.

Identical specimens were found in two localities on the north coast of Sealand, growing in *Dumontia filiformis* in the month of May. It cannot be confused with any other known species. As to its relation to *Ch. cytophaga* see this species.

Localities. **Ke**: Harbour of Gilleleje, inner side of the mole. — **Su**: Harbour of Helsingør.

18. *Chantransia Nemalionis* (De Not.) Ard. et Straf.

ARDISSONE e STRAFFORELLO, Enum. delle Alghe di Liguria, Milano 1877 p. 167.

Callithamnion Nemalionis DE NOTARIS, Erbar. Crittogam. Italiano, no. 952 (c. descript.); ARDISSONE, Prospetto delle Ceramiee italiane, 1867 p. 17, Tav. I fig. 1–3.

Acrochaetium Nemalionis BORNET (1904) p. XX.

Chantransia Saviana (Menegh.) ARDISSONE, Phycol. Mediterr. 1883 p. 276 ex parte.

As shown by BORNET, the *Callithamnion Nemalionis* described by DE NOTARIS has a system of filaments endophytic in the frond of *Nemalion lubricum*, on which it forms numerous 4–5 mm. high tufts. The same mode of growth was observed in a *Chantransia* growing in *Nemalion multifidum* at Struer in the Limfjord. As it fully agreed with the description of DE NOTARIS and with his above-quoted original specimens, which I have been enabled to examine through the great kindness of Dr. BORNET, I refer it to the same species without any doubt. ARDISSONE has later confused this species with one or perhaps more others under the name of *Chantransia Saviana* (Menegh.) Ard.; as however MENEGHINI's description refers to a species growing on *Zostera* leaves and certainly different from DE NOTARIS' species, it is unwarranted to replace the name of the latter with that of MENEGHINI.

The plant has long ramified filaments growing widely in the interior of the host and here and there sending out through the surface of the host free filaments giving rise to new tufts; the number of tufts occurring on the same frond of *Nemalion* may therefore be very great. The walls of the endophytic filaments are often a little sinuous on account of their growth between the cells of the host; the cells are usually 8 to 11 μ thick, 3.5 to 5 diameters long. They contain in the middle a narrow belt-shaped chromatophore with a parietal pyrenoid. When the endophytic filaments rise from the basal part of the erect filaments they are given off from the lower end of the cells while the upright branches are given off at their upper end, and a similar polarity is as a rule, though not always, present in the endophytic filaments (fig. 54 A).

The erect filaments greatly resemble those of *Ch. corymbifera* and *Ch. Thuretii*; they form up to 5 mm. high tufts with spread branches which are multilateral but

with some tendency to unilaterality. The cells are cylindrical, not constricted at the transverse walls, $(7,5-9-11(-12)\mu$ broad, 3-7, usually 4-5 diameters long. They contain a parietal chromatophore with a large parietal pyrenoid much projecting into the interior of the cell. In the older cells the chromatophore is larger than in the younger and perhaps somewhat lobed. Hyaline hairs do not occur. The germination was unfortunately not observed.

The sporangia are borne on branchlets, usually placed on the inner side of the branches near their base, very often two or three seriate. The branchlets are as a rule one- or two-celled; in the first case it bears a terminal and a lateral sporangium, in the latter the upper cell behaves in the same way, while the lower cell bears one or two sporangia. It happens however that the branchlets may consist of more than two cells and that they may be branched (fig. 54 D). Only rarely the sporangia may be sessile directly on the filaments. The sporangia are always monosporous, oblong, $18-19\mu$ long, $9-10,5\mu$ broad. Renewal of the emptied sporangia from the underlying cell frequently occurs.

As already said, the Danish specimens agree with the original specimens of DE NOTARIS from Genoa. ARDISSONE figures certainly only two single, apparently sessile sporangia (1867 fig. 3); the sporangia are however nearly always borne on branchlets at least two together in DE NOTARIS specimens as well as in mine.

This species greatly resembles *Ch. corymbifera* Thur.¹, which grows on *Helminthocladia purpurea*. It differs from it by the absence of sex-organs and by the want of a larger cell originating from the germinating spore and giving off erect filaments and descending endophytic filaments. In spite of repeated search I have never found such a cell and that is in accordance with BORNET's statement



Fig. 53.

Chantransia Nematolionis. Erect filament with sporangia, below an endophytic filament. 95:1.

¹ G. THURET in LE JOLIS Liste p. 107; BORNET et THURET, Not. alg. I p. 17 pl. V; BORNET 1904, p. XX.

that the cell rising from the germinating spore is not different from the cells which it produces. To judge from the figures of BORNET and THURET the sporangia become a little larger in *Ch. corymbifera* than in *Ch. Nemalionis*, namely up to 22μ long. It is interesting that this species hitherto only known from the Mediterranean and the Gulf of Gascony has been found in the Limfjord, a water with relatively high salinity and summer temperature.

Locality. Lf: Struer, outer side of the mole, September.

19. *Chantransia endozoica* Darbish.

O. V. DARBISHIRE, *Chantransia endozoica* Darbish., eine neue Florideen-Art. Ber. deutsch. bot. Ges. 1899, Bd. 17 p. 13 Tafel I.

The greater part of the frond of this species grows in the thick outer wall of the Bryozoan *Alcyonidium gelatinosum*. The endozoic filaments are dichotomously branched and give off numerous free, short, branched fertile filaments bearing monosporangia. I have only met with very few specimens and must therefore content myself by referring to the above-quoted paper of DARBISHIRE. I regret that I am not

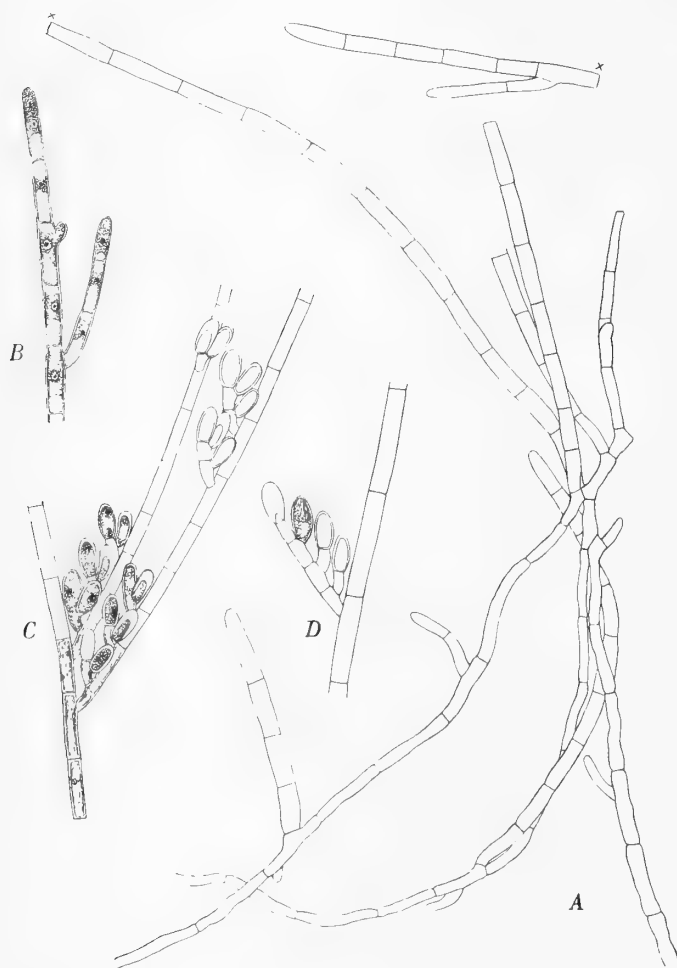


Fig. 54.

Chantransia Nemalionis. A, endophytic filaments giving off a number of erect filaments. B, upper end of erect filament showing chromatophores with pyrenoid. C and D, filaments with sporangia-bearing branchlets. 200:1.

able, any more than this author, to give information on the form and structure of the chromatophore. The sporangia were $13.5-17\mu$ long, $9-10\mu$ broad.

Locality. Sk: In a specimen of *Alcyonidium gelatinosum* washed ashore on the beach of Hirsals, August, with ripe sporangia.

20. *Chantransia emergens* sp. nov.

Fila vegetativa endophytica infra cuticulam hospitis (*Polysiphonia urceolatae*) horizontaliter expansa, ramosa, ramis sparsis vel oppositis, sub angulo recto plerumque

egredientibus, cellulis subcylindricis medio vel paullo supra medium plus minus inflatis, 6–10,5 μ longis, 2–3,5 μ latis. Chromatophorum ut videtur, unicum parietale pyrenoide instructum. Pili hyalini desunt. Monosporangia extra cuticulam emergentia solitaria breviter stipitata, stipite unicellulari, rarius in filis endophyticis sessilia, ovata, 5–6,5 μ longa, 3–4 μ lata.

In a specimen of *Polysiphonia urceolata* dredged in the Skagerak off Hirshals

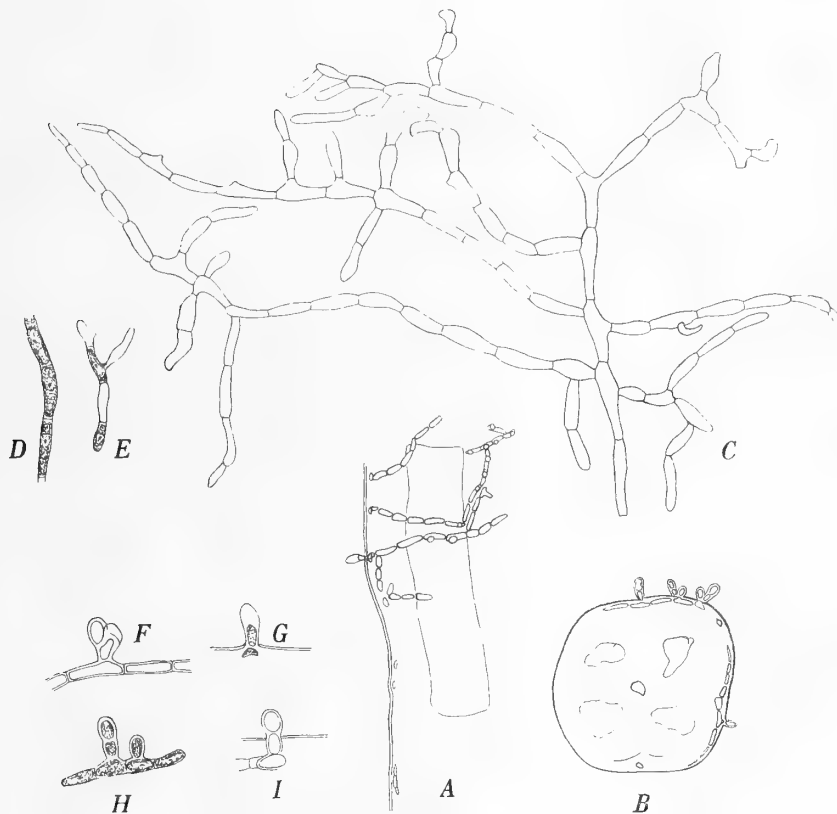


Fig. 55.

Chantransia emergens. A, filaments growing under the cuticle of the host, seen partly from the face partly in profile (at left); a pericentral cell of *Polysiphonia* is shown. B, transverse section of *Polysiphonia* with the endophyte. C, endophytic filaments. D and E, cells showing the chromatophore and the supposed pyrenoid. F–I, filaments with sporangial branchlets seen in profile, in G an emptied sporangium, in F a new sporangium is formed besides an emptied one. A–B 290:1, C–I 610:1.

this little species was found rather abundantly, growing in the outer wall close within the cuticle but never penetrating into the radial walls between the pericentral cells. The filaments are very thin, the cells very thin-walled, usually 3–5 diameters long; they were in the dried specimens, the only ones I examined, uniformly rose-coloured and seemed to contain a parietal chromatophore occupying the greater part of the periphery of the cell. In the middle or somewhat over

the middle of the cell a body staining in hæmalum is visible, probably a pyrenoid. The branches are given off at a certain distance from the acroscopic transverse wall, sometimes from the middle of the cell or even, though rarely, a little under the middle. All the vegetative branches are given off in a plane parallel to the surface of the host, while the extremely short fertile branchlets break through the cuticle in a direction perpendicular to that plane. These branchlets consist of a short partly immersed stalk-cell and an entirely free sporangium, but sporangia arising directly from the endophytic filaments also occur. In the fertile part of the plant a sporangium is usually given off from each cell in the endophytic filament (fig. 55 A). After the evacuation a new sporangium may be formed within the empty sporangial wall, but it may also occur that a new lateral sporangium is given off from the stalk cell besides the emptied terminal one.

The species appears to be nearly related to *Acrochaetium endophyticum* BATTERS (Journ. of Botany Vol. 34 1896 p. 386) living in "the cortical layer" of *Heterosiphonia coccinea*. As far as can be seen from BATTERS' description this species is distinguished from *Ch. emergens* mainly by longer erect filaments, which are composed of from one to three cells.

Locality. Sk: Møllegrund off Hirshals (XO), 11,5 to 15 meters, with ripe sporangia in August.

21. *Chantransia immersa* sp. nov.

Thallus endophyticus; fila omnino immersa, intercellularia, varie ramosa, ramis sparsis vel ex una cellula pluribus egredientibus. Cellulæ nunc cylindricæ plerumque tamen medio vel supra medium inflatæ, 8—10 μ latæ, 40—53 μ longæ, nunc, præcipue superficiem hospitis versus, breviores plus minus rotundatæ, usque ad 15 μ latæ. Chromatophorum unicum stellare pyrenoide centrali et ramis longis sursum et deorsum protractis munitum. Cellulæ ultimæ breves obovatæ vel rotundatæ, in superficie hospitis prorumpunt, cellulas periphericas illius plerumque non superantes, nonnunquam pilum hyalinum gerentes. Sporangia, transformatione cellularum ultimarum orta, obovata, 15—17,5 μ longa, 11—12 μ lata, monospora, post evacuationem sæpe sporangio novo e cellula suffultoria formato repleta.

This species occurs in *Rhodomela subfusca* and in species of *Polysiphonia*. As the endophytes are essentially identical in structure, they are referred to the same species, but as their behaviour to the different hosts is somewhat different, two forms may be distinguished.

Forma *Rhodomelæ*. In *Rhodomela* I have only found the endophyte growing in tumours and occurring in fairly great quantity at Frederikshavn in July 1895 and 1896. These tumours are irregularly roundish and somewhat remind one in form and size of *Harveyella mirabilis*. I conclude that they are occasioned by this endophyte, but it deserves notice that these tumours also contained an endophytic *Ectocarpus* or *Streblonema* and the very common endophyte *Bolbocoleon piliferum*. The *Chantransia* grows intercellularly through the whole tumour, the filaments running mainly in a radial direction. The swellings have essentially the same

structure as the normal branches; there appears to take place only an acceleration of the growth, their structure assuming the appearance of that of much older branches. In the interior of the tumour the cells of the endophyte are usually several times as long as broad, nearly cylindrical; towards the periphery they become shorter, lastly only a little longer than broad. At the same time the filaments become more branched. The outermost cells reaching the surface of the host bear sometimes a short hair ca. $4.5\ \mu$ thick at the base but quickly tapering upwards.

The structure of the cells

was studied on material hardened with picric acid. The pyrenoid is large and contains an angular body, probably a crystalloid. It is situated nearly in the middle of the cell but not always

in the axis of the cell (fig. 57 *B*, *C*). The arms of the chromatophore are long and narrow and extend from the central part containing the pyrenoid upwards and downwards to the ends of the cell. The nucleus is difficult to see; by aid of borax-carminé it was determined in young cells, lying in a pit in the chromatophore near the pyrenoid (fig. 57 *A*, *n*).

The sporangia arise almost without change of form from the outermost cells lying at the level of the surface of the host or a little prominent. After the evacuation a new sporangium may be formed within the emptied wall from the under-lying cell (fig. 56 *A*).

Forma Polysiphoniæ. Of this form which has been found growing in *Polysiphonia nigrescens* and *P. violacea* I have particularly examined specimens infesting *P. nigrescens* collected at Hirsholmene in September. It occasions here no tumours but grows intercellularly between the central cell and the pericentral cells as well as between the latter mutually. Long straight filaments consisting of cylindrical or feebly swollen cells often run

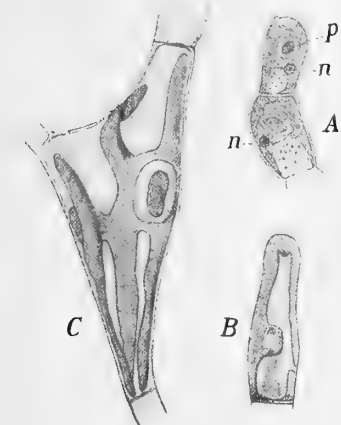


Fig. 57.

Chantrelaria immersa f. *Rhodomele*. Cells showing the chromatophore; hardened with picric acid. *A*, young cells, *p*, pyrenoid, *n*, nucleus. *B*, the pyrenoid contains a crystalloid. *C*, the chromatophore with long arms, the pyrenoid excentric. *A* 730:1. *B* 580:1. *C* 1100:1.

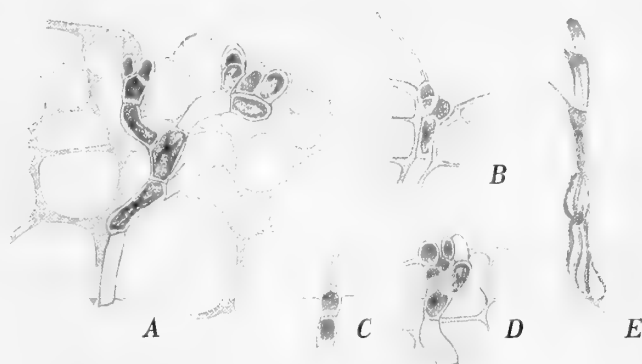


Fig. 56.

Chantrelaria immersa f. *Rhodomele*. *A*, section of tumour of *Rhodomele* with the endophyte; a new sporangium is about to be formed within an emptied sporangial-wall. *B* and *C*, ends of filaments with hair. *D*, filament with sporangia, one emptied. *E*, filament showing the chromatophores. 300:1.

longitudinally between the central cell and the pericentral cells, sending off between the pericentral cells radiating filaments ending with short cells breaking through

the cuticle of the host (fig. 58 C, E). But longitudinal filaments running a short distance from the surface between the pericentral cells also occur, and these filaments give off short unicellular branchlets (fig. 58 F). The peripheral cells may reach the surface of the host or be somewhat prominent, and the same is the case with the sporangia; these are only seldom so prominent as that shown in fig. 58 C. The

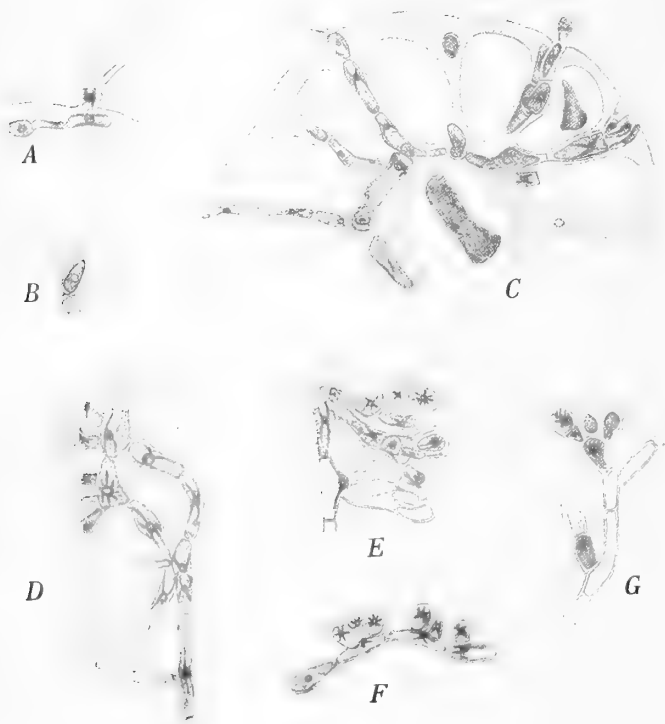


Fig. 58.

Chantransia immersa f. *Polysiphoniæ*. A, filament giving off an emerging cell bearing two hairs. B, end of filament with hair. C, transverse section of *Polysiphonia nigrescens* with the endophyte. D and E, longitudinal filaments giving off radiating filaments with sporangia. F, longitudinal filament with unicellular branchlets. G, filament with sporangia-bearing branches. 300:1.

in the same, Sept.; Trindelen (NI), 9,5 to 10,5 met., in *Polys. violacea*, Sept.

peripheral cells bear sometimes a hair which may be more vigorous than in f. *Rhodomelæ* and two hairs in one cell may even be observed (fig. 58 A). The chromatophore has the same structure as in f. *Rhodomelæ*, and the sporangia are also alike. Formation of a new sporangium within an emptied sporangial wall frequently occurs, apparently repeatedly (fig. 58 C, D, G). The sporangia were as a rule better developed than in f. *Rhodomelæ*, probably on account of the later season.

The more or less immersed monosporangia distinguish this species from all other described endophytic *Chantransiæ* known to me.

Localities. Forma *Rhodomelæ*. Kn: Frederikshavn, outer side of the mole.

Forma *Polysiphoniæ*. Kn: Hirschholmene, in *Polysiphonia nigrescens*, September; dry rock at Jegens Odde

22. *Chantransia Polyidis* sp. nov.

Thallus endophyticus; fila in cortice exteriori et interiori hospitis (*Polyidis rotundi*) intercellularia, vario modo, in directione radiali et transversali vel etiam intermedia, præsertim tamen radiali, peripheriam versus crescentia, ramosa, ramis sparsis. Cellulæ forma varia, plerumque cylindricæ vel utriculosæ, sæpe aliquantum curvatæ, long. 30—56 μ , lat. 10,5—14 μ , peripheriam versus breviores, adultæ ut videtur chromatophorum unicum valde ramosum, fere reticulatum continentes. Cellulæ ultimæ rotundatæ, oblongæ vel clavatæ, superficiem hospitis attingentes sed

non superantes, raro pilum paullo evolutum portant. Sporangia in apice filorum radiantium singula vel rarius bina, immersa, superficiem hospitis non vel vix superantia, monospora, oblonga, long. 15,5—18 μ , lat. 9 μ .

This species was found only once in dried specimens of *Polyides rotundus* collected in the Northern Kattegat in September. In mode of growth it reminds one somewhat of *Ch. immersa* from which it is distinguished in particular by the form of the chromatophore. It does

not occasion any deformation of the host plant in the intercellular substance of which it lives. It grows principally in a radial direction but has also stoloniform filaments growing out in a transverse direction and giving off new radiating filaments (fig. 59). The filaments are as a rule fairly strongly branched, however, one branch only is given off from each joint, and some cells bear no branch. Sometimes the branches are fasciculated in the radial filaments (fig. 59 A). The cells are usually

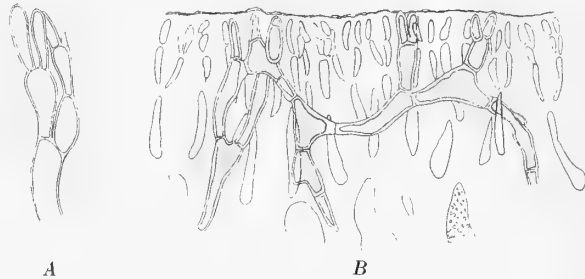


Fig. 59.

Chantrelaria Polyidis. A, radiating filament with fasciculated branches. B, transverse section of *Polyides* with *Chantrelaria* showing transverse and radiating filaments. 300:1.

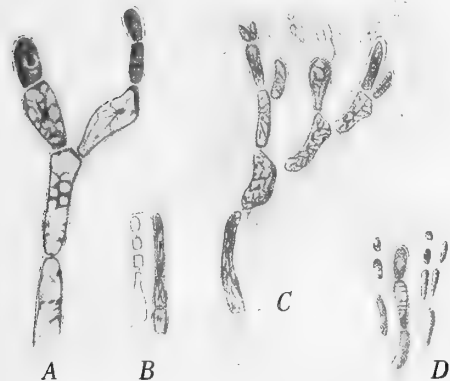


Fig. 60.

Chantrelaria Polyidis. A, radiating filament showing the chromatophores. B, end of filament the end-cell of which is apparently about to form a hair. C, branched filament with partly emptied sporangia. D, end of filament with terminal sporangium. A 390:1. B-D 300:1.

somewhat swollen; at some distance from the surface very thick cells, over 20 μ broad, may frequently be met with. Hyaline hairs seem to occur only in very small quantity and feebly developed. The end-cell shown in fig. 60 B is probably a young hair which has not yet reached above the surface of the host.

As I possess only dried material I cannot give a sufficient account of the structure of the chromatophore, which seems to be rather peculiar. In the end-cells the chromatophore appears often as a compact mass filling out the greater part of the cell, in the centre of which a body is visible which seems to be a pyrenoid (fig. 60 A). In the somewhat older cells the chromatophore shows often an upper dome-shaped part while the rest of it is divided into a number of strands or plates, concerning

which I am not able to decide if they are all continuous or partly separate. The dome-shaped part soon disappears and the supposed pyrenoid was also as a rule not visible in the more developed cells. The whole process has apparently the character of a vacuolization of the chromatophore.

The sporangia are terminal on the outward growing filaments. Besides the

really terminal sporangium another lateral is often developed, inserted at the same level. The sporangia are entirely immersed or only a little prominent above the surface of the host; they are about twice as long as broad.

Locality. **K11**: Tønneberg Banke, TP, 16 meters, September.

Subgenus *Grania*.

Group IV. Frond epiphytic (or partly endozoic); chromatophores long, usually spiral-shaped, more than one; carpogonia often intercalary, carpospores seriate.

23. *Chantransia efflorescens* (J. Ag.) Kjellm.

KJELLMAN, N. Ish. algfl. p. 166 (Alg. Arct. Sea p. 129) tab. 12 fig. 1—2 (*f. tenuis* Kjellm.); GRAN, Kristianiaff. Algefl. p. 19 tab. I fig. 1—3; E. LEHMANN, Beitr. z. Kenntn. von *Chantransia efflorescens* J. Ag. sp., Wiss. Meeresuntersuch. N. F. 6. Bd. Abt. Kiel 1902 p. 1, Taf. I; BØRGESEN (1902) p. 355; KYLIN (1906) p. 113. *Trentepohlia Dawiesii* a. ARESCHOUG, Phyc. Scand. 1846 p. 117. tab. V D. *Callithamnion efflorescens* J. AGARDH, Sp. Vol. II p. 15. *Rhodochorton chantransioides* REINKE, Algenfl. p. 23, Atlas Deutsch. Meeresalg. Taf. 21.

Much has been added to our knowledge of this interesting Alga during the last thirteen years. GRAN described the sex-organs in 1896, showing that the formerly known clusters of spores were cystocarps. According to GRAN and other observers the sexual plants do not bear sporangia; but later, sporangia have been observed on other individuals supposed to belong to the same species. Thus, in 1902 E. LEHMANN recorded monosporangia-bearing plants growing together with sexual plants on stones in the bay of Kiel, and in the same year BØRGESEN mentioned similar plants with monosporangia found at the Faeroes, while sexual plants were not met with. Finally, KYLIN has shown in 1906 that *Rhodochorton chantransioides* REINKE belongs to this species, representing an asexual generation provided with tetrasporangia. KYLIN doubts, however, that the asexual plants mentioned by LEHMANN and BØRGESEN ought to be referred to this species, as they bear monosporangia and have somewhat thicker filaments than the Swedish specimens.

Referring to the careful description of the species by KYLIN, it must be pointed out that I do not fully agree with this author in the delimitation of the species, as I have found that it may have monosporangia as well as tetrasporangia, and that the filaments may often be somewhat thicker than stated by him. While the filaments according to KYLIN are $5\ \mu$ thick, I have found, on the basis of a great number of measurements, that in plants from all Danish waters they are usually $5\text{--}6\ \mu$ thick, but that the thickness varies from 4 to $7.5\ \mu$. My observations are not sufficiently numerous to allow any certain conclusion as to the influence of the outer conditions upon the thickness; I shall only state that the specimens from the Baltic were $4\text{--}5\ \mu$ thick, while plants collected in the North Sea in 38 meters depth were $6\ \mu$ thick.

The germination, which was hitherto unknown, has been studied in specimens growing on the theca of a hydroid polyp, collected in the Samsø Waters (YV) in

June. The germinating plants were found among fully developed plants bearing monosporangia and originated undoubtedly from monospores. As shown in fig. 61 the germinating spore becomes a hemispherical basal cell the diameter of which is much greater than that of the filaments, namely 8—10 μ . This cell keeps its form, at all events for some time, and divides only by peripheral walls, by ramification. An erect filament is early given off from the upper face of the cell, and from the margin small cells are cut off which grow out into irregularly bent creeping filaments. In somewhat older plants two erect filaments rising from the basal cell and an increasing number of radiating creeping filaments are visible (fig. 61 *E*). In some cases it was observed that a filament, after having run some distance on the surface of the wall of the hydroid, had suddenly penetrated the wall and continued its way within it (fig. 61 *E*). I do not know if this species can also penetrate the Algæ on which it grows. LEHMANN figures a basal part of the *f. petrophila* described by him (l. c. fig. 10), which is rather different from the young stages observed by me, as it is a parenchymatous disc giving off three erect filaments from three different cells, and no cell is distinguishable as being the originally single basal cell. The difference may be possibly due to the difference in age, in part also to the different substratum.

As shown by KYLIN, free descending filaments often occur in the lower part of the plant; they are met with in the asexual individuals as well as in the sexual plants; in the first named, however, they are often wanting.

The chromatophores are, as shown by REINKE and KYLIN, parietal spiral-shaped bands. Usually there appears to be two, sometimes only one, and in other cases they are more irregular, either more numerous or more branched, a matter difficult to decide. LEHMANN states expressly that the cells contain one much-branched chromatophore only, the apparently distinct chromatophores being always connected by anastomoses. Though this statement is in contradiction to the figures of KUCKUCK (REINKE, Atlas Taf. 21 fig. 3) and KYLIN and though I also think I have observed more than one chromatophore

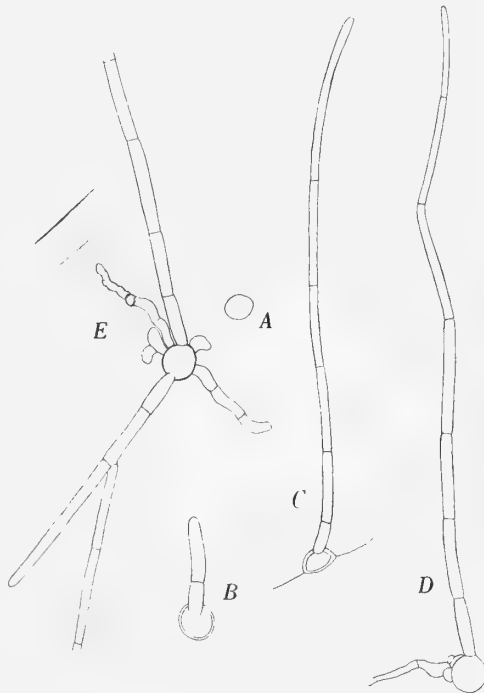


Fig. 61.

Chantransia efflorescens. Germinating plant on tube of Hydroid, from YV, June 1904. A, spore, provided with membrane but still undivided. B, the basal cell has given off an erect filament. C, older plant in the same stage. D, creeping filaments are given off from the periphery of the basal cell. E, the basal cell has given off two erect and four creeping filaments; one of the latter has penetrated into the membrane of the Hydroid. The endozoic part of the filament is shaded. 560:1.

in the cells (fig. 64), I dare not deny it decidedly, as it is in reality very difficult to convince oneself of the absence of anastomoses between the chromatophores, which never run quite regularly. According to KYLIN (l. c. p. 115) the chromatophores contain small granules which are interpreted by him as pyrenoids. I have observed the same granules but cannot give any information as to their nature; their appearance seemed not to be constant. While the cells in LEHMANN'S specimens contained fat and no starch, I found in cystocarp-bearing specimens the vegetative cells containing no fat but minute starch-grains staining red-brown in iodine, and the cystocarps, especially the carpospores, contained a great quantity of the same substance. The reaction with iodine was rather similar to that of glycogen.

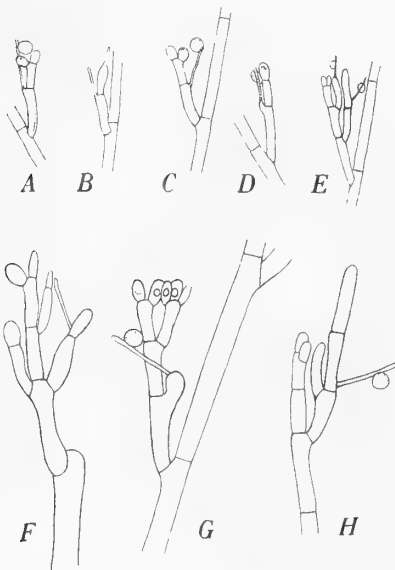


Fig. 62.

Chantrelaria efflorescens. Fertile branchlets. See the text. The carpogonia and the cells produced by them after fertilisation are shaded. A—D 390:1. E 300:1. F—H 620:1.

they are lateral. In the same branchlet a lateral and a terminal carpogonium frequently occur. The intercalary carpogonia show very often a swelling at the base of the trichogyne (fig. 62 D) which may formerly perhaps have been interpreted as the whole ventral part of the carpogonium. Fertilized carpogonia with adhering globular spermatia frequently occur. After fertilization the separation of the trichogyne takes place in the intercalary carpogonia at the upper end of the swelling (fig. 62 G). Thereafter the fertilized carpogonium increases in length, the trichogyne is pushed aside, and the lengthened body divides by a transverse wall a little under the insertion of the trichogyne (fig. 62 E, F, H). Even in this stage and later the trichogyne with adhering spermatium may yet be visible. In fig. 62 H the primary filament of the young cystocarp is three-celled and has produced a

The sex-organs develop, as shown by GRAN, on special fertile branchlets, generally very near each other. Later, KYLIN has accounted for the various combinations of the sex-organs on the same branchlet, but he has not noticed the curious fact that the carpogonia are not always lateral on the fertile branchlet but often intercalary, rising by transformation of the second or even the third cell from the top. The intercalary carpogonia, which were already observed in 1893 by the late Professor FR. SCHMITZ who mentioned them in a letter to me, are very common. A very frequent case is represented in fig. 62 A, C, D where the lower cell in a two-celled branch has become a carpogonium, pushing forward a trichogyne from the upper end of the cell along the upper cell which in all cases is sterile bearing two antheridia. In fig. 62 B both the cells have developed into carpogonia, the one superposed on the other. In fig. 62 G the carpogonium has arisen from the lowest cell in a three-celled branched branchlet, and in fig. 62 E and F

branch. The further divisions and branchings I have not followed; they result in the formation of a glomerule of radiating filaments, the two or three last cells of which are swollen and produce each a carpospore. As each fertile branch bears as a rule more than one carpogonium, the glomerules may perhaps sometimes be composed of two or even three cystocarps, being thus syncarps. The position of the antheridia in the neighbourhood of the carpogonia results in emptied antheridia being frequently visible in ripe cystocarpia amongst the spore-producing filaments (fig. 63).

I have no doubt that KYLIN is perfectly right in referring the *Rhodochorton chantransioides* to this species, as it agrees with it in all but the reproduction. However, the tetraspore-bearing plants are as a rule smaller, ca. 2 mm. high, and it may be added that they usually form continuous felted coverings while the sexual plants form isolated tufts. On the other hand specimens fully agreeing with those described by REINKE and KYLIN, only bearing monosporangia instead of tetrasporangia, also occur. Young still undivided tetrasporangia are out of the question in this connection, for I have in many cases met with specimens bearing numerous well-developed monosporangia, some of which were emptied but not one with divided contents. Usually each plant bears either tetrasporangia or monosporangia, but the two kinds of plants often grow together side by side, as the plants represented in fig. 64. The only difference is that the monosporangia are smaller than the tetrasporangia. The monosporangia I found (10—) 11—18 μ long, 5—7 (—8,5) μ broad, the tetrasporangia 15—28 μ long, 8—12,5 μ broad. Referring to the above quoted descriptions it may be added that two sporangia-bearing branchlets are frequently sitting on one cell in the monosporangia-bearing as well as in the tetrasporangia-bearing plants; they are usually opposite but may also be placed near each other on one side of the filament (fig. 64).

The species has been met with in the Danish waters in the months April to August. Sporangia-bearing plants occur in April to June, more rarely in July. Sex-organs have been met with in all the months named, fully developed cystocarps only in June to August. This in connection with the fact that the two kinds of reproductive organs occur in different individuals suggest the existence of an alternation of an asexual generation appearing in spring with a sexual one occurring principally in summer. If this supposition is right, the germinating plants mentioned above (fig. 61) must be young sexual plants. Unfortunately LEHMANN does



Fig. 63.

Chantransia efflorescens. Branchlet with ripe cystocarp showing still two emptied antheridia at the top of the branchlet. 835:1.

not mention if the basal disc figured by him (l. c. fig. 10) belonged to an asexual or a sexual plant.

The species attains in the Danish waters a length of 5 mm., but it is relatively seldom more than 3 mm. high. As mentioned above, the asexual plants are as a rule smaller than the sexual ones; however I have found in the Little Belt a specimen with monosporangia measuring 5 mm. in length. It grows principally on other Algæ; I have recorded it on 15 different species, most frequently on *Delesseria sanguinea*, *Furcellaria*, *Desmarestia aculeata*, *Cystoclonium purpurascens*, *Polysiphonia elongata*, further on leaves and roots of *Zostera*, on tubes of Hydroids, Ascidians, shells of *Buccinum* and finally on stones. It has been met with in depths of 7,5 to 38 meters, most frequently 11 to 23 meters. In the following list of localities the depth is only indicated when it is outside the last named limits. It is interesting that this sub-arctic species has been met with in nearly all the Danish waters, also in the Baltic, but not in the Limfjord nor in other shallow waters where the summer temperature is comparatively high.

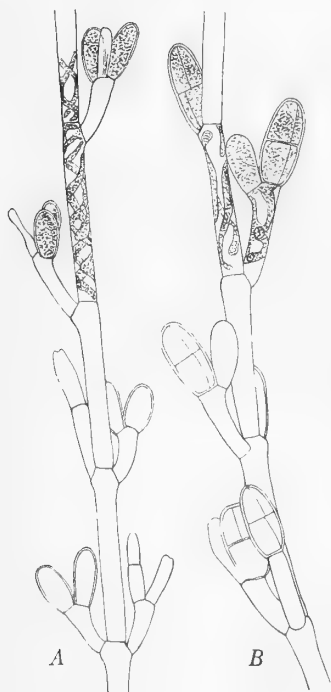


Fig. 64.

Chantransia efflorescens. A, filament with monosporangia, partly emptied. B, filament with tetrasporangia. 500:1.

Localities. **Ns**: AG near the Jutland Reef, 28 met. — **Kn**: FG, Herthas Flak; FH near Frederikshavn 4—7,5 met.; VU and VT, 9,5 met., N. of Læsø. — **Ke**: FC; ZE¹ and VY, Fladen; IK, Lille Middelfart; IA, Store Middelfart; RL. — **Km**: XF, Læsø channel, 8,5 met. — **Ks**: OS, Hastens Grund. — **Sa**: FS, Vejrø Sund; YV, south of Hatterbarn; DK, Bolsaxen. — **Lb**: XP, Middelfart; common around Fænø. — **Sb**: Z; near Sprogø (Ostenfeld); Langelandsbelt: UH, UT and LB. — **Su**: bM, south of Hveen; OG¹. — **Bw**: LC, south of Lange-land; Femerbelt: UL and KX. — **Bb**: XZ¹, Davids Banke, 19—20,5 met.

24. *Chantransia pectinata* Kylin.

KYLIN (1906) p. 120.

I have repeatedly met with a *Chantransia* agreeing with KYLIN's description and figures of this species, which appears to be related to *Ch. efflorescens*. The only discordance is that in some cases I have found free descending filaments near the base of the erect filaments, while *Ch. pectinata* according to KYLIN is distinguished from *Ch. efflorescens* just by the want of such filaments. They occur however seldom and are not so long as in the latter and they appear to have partly the character of stolons, growing out in horizontal direction (fig. 65 C). In spite of the presence of these filaments I regard the two named species as quite distinct, *Ch. pectinata* being characterized by thicker filaments, shorter, more thick-walled cells and by the sporangia-bearing branchlets being seriate on the inner side of the lateral filaments.

The main filaments were in my specimens 6—9 μ thick near the base; they are repeatedly branched. Opposite branches sometimes occur (fig. 65 D). The branches are tapering upward, finally only 3,5—4 μ thick. The cells of the main filaments are usually 4—7 times as long as broad. As shown by KYLIN, the chromatophores have almost the same shape as in *Ch. efflorescens*; they may also contain small refractive bodies which are possibly pyrenoids.

The sporangia-bearing branchlets are sometimes composed of more than 3 cells and transitions to longer filaments may then occur. Sometimes the sporangia may also be terminal on long filaments (fig. 65 A). The sporangia are always monosporous; after the evacuation a new sporangium is often formed within the emptied membrane. In some cases the sporangial wall was distinctly lamellate, consisting of two layers at least (fig. 65 A, B) in other cases this could not be observed. The sporangia were in the Danish specimens 10—14 μ long, 5,5—7,5 μ , most frequently 7 μ thick.

The species has been found in depths of 13 to 24,5 meters, growing on *Phyllophora Brodiaei*, *Desmarestia aculeata*, *Buccinum undatum* and *Flustra foliacea*, in June and July.

Localities. Ke: VZ, Groves Flak. — Lb: Fænø Sund and N. and W. of Fænø.

β , cimbrica var. nov.

Filis principalibus crassioribus, inferne 8—10,5 μ crassis, sporangiis partim tetrasporis 18—19 μ longis, 10,5—13 μ latis, partim monosporis, 11—13 μ longis, 6—8 μ latis.

In the Skagerak a *Chantransia* was found in May, growing on *Flustra foliacea*, which differed from the typical *Ch. pectinata* by thicker filaments and by the presence of tetrasporangia, but for the rest resembling the latter so much that it must be considered as a variety or form. Some specimens were almost the same as the typical species or only differing by a little thicker filaments, having the typical seriate sporangia-bearing branchlets with monosporangia. But others showed less numerous fertile branchlets bearing at most 2 sporangia, which were larger than the others and containing 4 spores. As I have had very scarce material I cannot say if the two kinds of sporangia may occur in the same individual. At all events

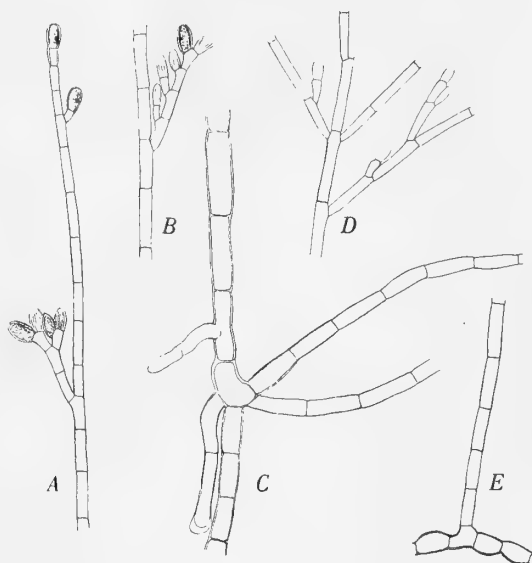


Fig. 65.

Chantransia pectinata. From Little Belt near Fænø. A, end of long filament with terminal sporangium and lateral sporangia-bearing branchlets. B, 4-celled sporangia-bearing branchlet. C, lower part of erect filament with descending and horizontally outgrowing filaments. D, erect filament with opposed branches. E, fragment of a filament of the basal layer with erect filament. A, B, D 270:1. C 560:1. E 350:1.

some specimens bore exclusively monosporangia; the tetrasporangia occurred only in small quantity.

As in the main species short descending filaments occurred at the base of the

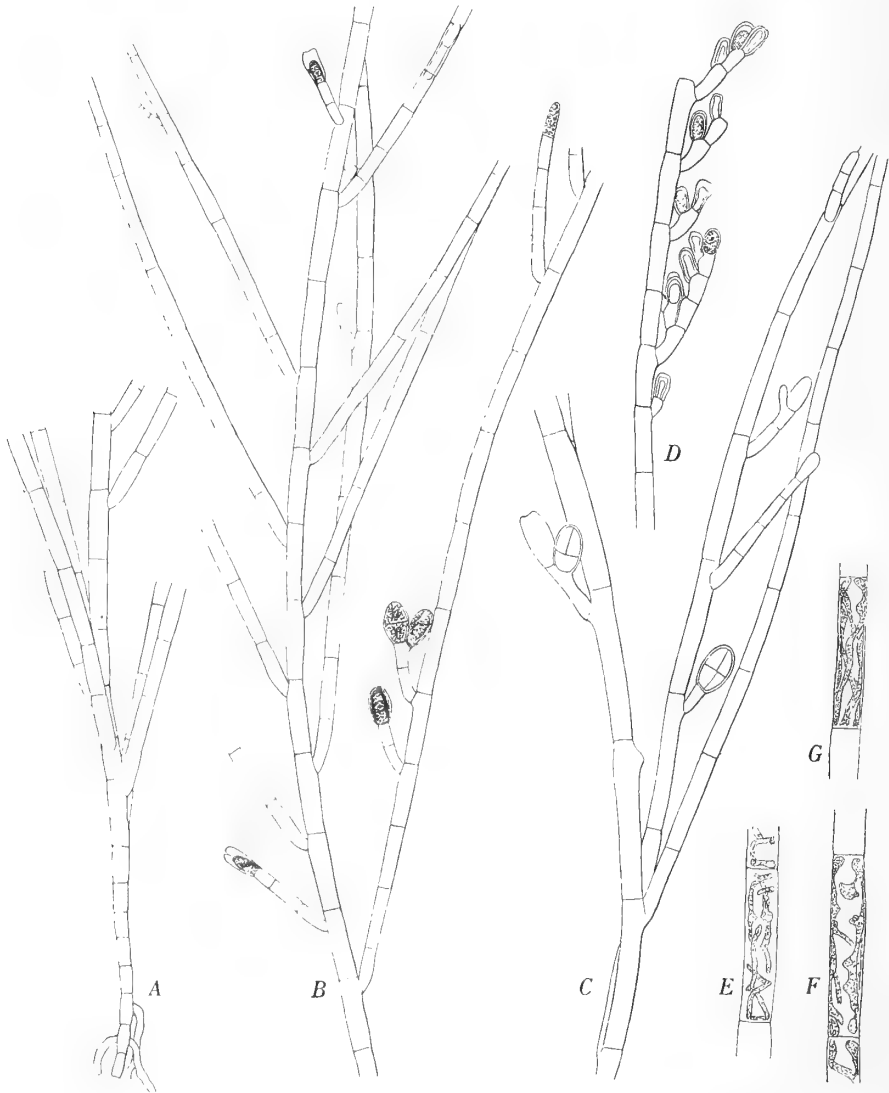


Fig. 66.

Chantrelaria pectinata ♀, *cimbrica*. *A*, lower part of erect filament. *B*, upper part of the same with sporangia; one of these showing a transverse wall. *C*, branched filament with tetrasporangia. *D*, filament with branchlets bearing monosporangia. *E*–*G*, cells showing the chromatophores. *A*, *B* 260:1. *C*, *D* 340:1. *E*–*G* 550:1.

erect filaments (fig. 66 *A*). The branches taper upwards, at last $5.5\ \mu$ thick. There is more than one chromatophore, parietal, long and narrow, sometimes spiral-shaped but more frequently rather irregular.

Similar specimens to those just described, but bearing only monosporangia, were found attached to *Flustra foliacea* near the Jutland Reef. To this variety may also be referred some small specimens found nearly in the same place as the first described, and on the same substratum (no. 7109). Their primary erect filaments were up to 11μ thick but consisted of rather short cells, $1,5-5$ diameters long, and the fertile branchlets were placed more irregularly, often on the primary filaments and occurred often in small quantity. As they otherwise agreed with the just described f. *cimbrica* they must be regarded as poorly developed specimens belonging to this variety.

Localities. Ns: aG, near the Jutland Reef, 38 meters, August. — Sk: N.W. of Hirshals, 13—15 meters, May.

Kylinia gen. nov.

Plantæ minutissimæ, habitu et crescendi modo *Chantransiæ*. E cellula basali germinatione sporæ orta fila libera plus minus ramosa horizontaliter egrediuntur. Monosporangia in filis terminalia vel lateralialia. Antheridia singula vel bina, in cellulis androphoricis erectis, multo angustioribus quam cellulis vegetativis, hyalinis, terminalia. Carpogonia terminalia vel lateralialia vel in cellula basali sita, post foecundationem primo latitudine aucta et longitudinaliter divisa. Carpospora ut videtur pauca oblonga vel leviter curvata, in una planitie subflabellatim disposita.

1. *Kylinia rosulata* sp. nov.

Cellula basalis hemisphærica fila plura, usque ad 7, horizontaliter emittens. Fila simplicia vel plus minus ramosa, ramis plerumque oppositis horizontaliter egredientibus. Cellulæ $4,5-5,5\mu$ crassæ, latitudine vulgo $1,5-2$ -plo longiores, rarius ultra, chromatophorum parietale continentes. Fila nonnunquam pilo hyalino tenuissimo terminata. Sporangia terminalia vel lateralialia, ovata, $6,5-8,5\mu$ longa, $5-5,5\mu$ lata. Cellulæ androphoricæ $1-1,5\mu$ latæ, c. $4-7\mu$ longæ, ad apicem et dorsum cellularum vegetativarum vel, ut videtur, carpogoniorum, singulæ rarius binæ. Antheridia $2-4\mu$ longa, $1,5-2,5\mu$ lata. Cystocarpia, ut videtur, paucicellularia, carposporis c. 3.

This curious little plant has only been met with once in the Northern Kattegat where it was found growing fairly abundantly on a specimen of *Sporochnus pedunculatus*. It occurred only on the assimilating filaments which form a tuft on the fertile branches of this plant, and their number was often so great that these filaments were rose-coloured in spite of the extreme smallness of the epiphyte. Its appearance is that of a *Chantransia* of the group with one basal cell; it is indeed somewhat similar to *Chantransia hallandica* γ , *parvula*. The basal cell is hemispherical, attached to the substratum by a thin layer of cementing substance (fig. 67E). It gives off at all sides in a horizontal direction, but not from the upper side, a number of filaments, in well developed plants 6 or 7. These filaments grow out along the surface of the filament of *Sporochnus* but are not attached to it; they

are thus growing in a cylinder, and the branching takes place in the same plane. The filaments attained only an inconsiderable length; I found them at most 5-celled. As I possess only dried specimens of the plant, I have not been able to determine with certainty the form of the chromatophore; I can only state that it is parietal and probably single. In the spores it appeared to be distinctly belt-shaped (fig. A—D, N). In some cases I believed I saw a pyrenoid (fig. H, P). The end-cells

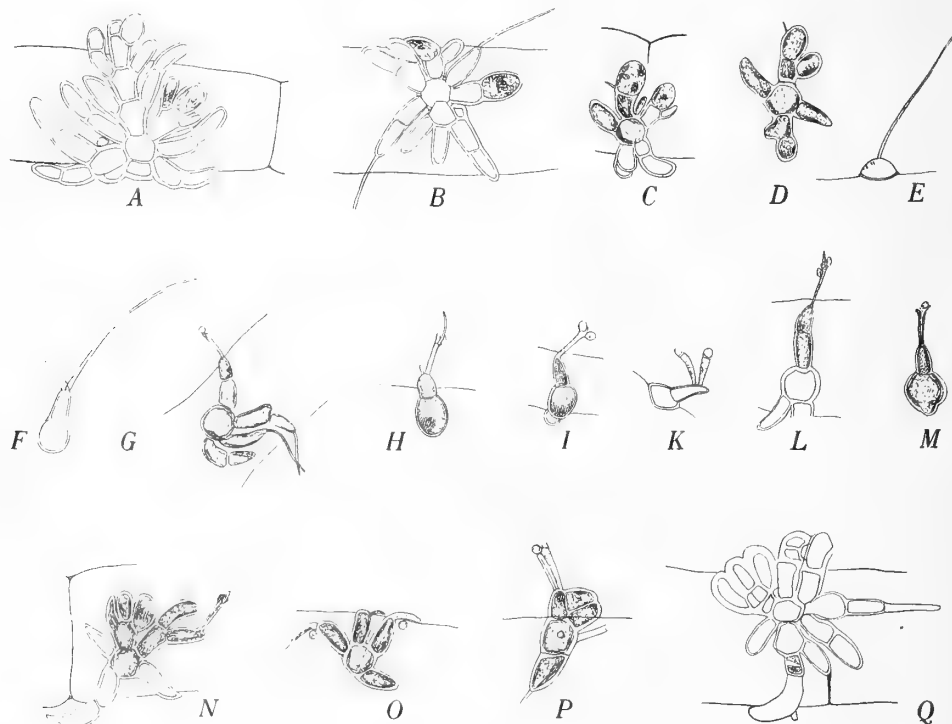


Fig. 67.

Kylinia rosulata. A—D, plants with sporangia. E, basal cell, still undivided, bearing a hair. F, plant consisting of a basal cell giving off a one-celled branch which bears a terminal hair and an androphore-cell with an antheridium. G, plant with androphore-cell. H, I, plants with androphore-cell bearing two antheridia. K, a cell giving off two androphore-cells. L, the outer cell in a two-celled filament transformed into a carpogonium: two spermatia adhering to the trichogyne (compare text). M, the cell given off from the basal cell seems to be a carpogonium: the threadlike organ to the right is probably the trichogyne, that to the left an androphore-cell. N, to the right probably a carpogone with adhering spermatium; at the upper side a short filament with sporangia. O, the thin cell to the left is probably a young androphore; above possibly a trichogyne. P, the basal cell bears to the right an androphore-cell, above a three-celled complex, probably a young cystocarp; this bears an androphore-cell with two antheridia and a trichogyne. Q, plant bearing above a three-celled, presumed young cystocarp and to the left a more developed cystocarp. 550:1.

bear frequently a very thin, hyaline hair tapering upwards; such a hair is also sometimes given off from the upper side of the basal cell even before branching. The plants are often much reduced, the basal cell giving off only one or a few short filaments consisting of one or very few cells (fig. E—M, P).

The sporangia-bearing plants bear usually no other reproductive organs. The sporangia are often terminal on primary filaments, being frequently separated from

the basal cell only by one sterile cell (fig. *A—D*). Sporangia sitting immediately on the basal cell I have not observed.

The antheridia arise at the end of peculiar narrow, cylindrical, colourless or feebly coloured cells given off from the apical end of the end-cells, not rarely from cells sitting directly on the basal cell; in fig. *P* such a cell is even situated directly on the basal cell. These androphore-cells, as they may be named, are not given off in the same plane as the other branches but rise more or less vertically from the horizontally directed cells. Usually one androphore only is given off from the same cell, but two androphores situated near each other also occur (fig. *K*). As mentioned below, the androphore-cells may also be situated on the carpogonia. The end of these androphore-cells gives rise to one or two antheridia. In the first case a small cell, a little longer than broad, is cut off by a transverse wall (fig. *F, G, K*), in the latter the antheridial cells are cut off by inclined walls from the end of the androphore-cell, leaving a little point between the two antheridia (fig. *H, I*); this point may sometimes be lengthened into a short hair-like organ.

As to the carpogonia and cystocarps, I am sorry to say that I have not arrived at clearness, on account of the state of preservation of the material and perhaps also because these organs occurred in very small number and in insufficient stages of development. In particular it appeared difficult to find unquestionable trichogynes. I think however that the cell shown to the right in fig. *N* is really a carpogonium with a spermatium attached to the trichogyne. In fig. *P* a cell-complex, probably a young cystocarp, is seen bearing an androphore and quite near to it a thin thread, which is perhaps a trichogyne, but no spermatium is attached to the latter. A similar case is shown in fig. *M*, where a cell bears two thin, threadlike organs, the one being certainly an androphore-cell, the other probably a trichogyne. The great resemblance between the androphore-cells and the trichogynes cause great difficulty, in particular when the antheridia are formed on the side of the androphore-cell. Thus the case represented in fig. *L* might perhaps raise some doubt. The resemblance between the filiform organ figured here and the androphores represented in figs. *H* and *I* might perhaps suggest that it is an androphore with two antheridia and prolonged point; the continuity of the protoplasmic contents in the filiform organ and that of the cell from which it is given off goes however to prove, that these two organs belong together, being a carpogonium, and that the two spermatia must have come from elsewhere and become attached to the trichogyne. Small round cells looking like spermatia have sometimes been found attached to various points on the surface of the plants (fig. *A, O, Q*). In the latter case (fig. *Q*) the small cell was adhering to a hyaline curved cell, the significance of which I do not know.

Of stages which could be supposed to be fertilized carpogonia or cystocarps I have only found very few. The three-celled complex situated at the side of the basal cell turned upwards in fig. *P* I regard as a young cystocarp. A similar three-celled stage is shown in fig. *Q* at the upper side, partly hidden by an over-

lying filament. If this interpretation is right, the fertilized carpogonium is first divided by a vertical wall and thereafter one of the daughter-cells is divided by a wall perpendicular to the first. The cell-complex shown to the left in fig. Q I take to be a more developed, perhaps a fully ripe cystocarp. The three larger, upwards directed cells are probably the carpospores; they are somewhat diverging, lying in one plane, the same as that of the branching of the plant. A stage so much developed was only once observed.

In spite of the likeness of our plant to the genus *Chantransia* in habit and in the monosporangia, it seems correct not to refer it to this genus but to regard it as the representative of a new genus, characterized in particular by the androphore cell being very different from the ordinary cells, and further by the development and structure of the cystocarps. Among the sexual species of *Chantransia*, *Ch. hallandica* seems to be the one where the cystocarp offers most similarity with that of *Kylinia*, but unfortunately its development is not known. The fact that the androphore-cell is often situated on the carpogonium is analogous to the above described case, that an antheridia-bearing cell is often superposed on the carpogonium in *Chantransia efflorescens*.

The genus is called after the Swedish phycologist, Dr. H. KYLIN, who has contributed so much to our knowledge of the northern marine Algæ.

Locality. KN: TP, Tønneberg Banke, 16 meters, on *Sporochnus pedunculatus*, September.

Tribe Nemalieæ.

Nemalion Targioni Tozzetti.

1. *Nemalion multifidum* (Web. et Mohr) J. Ag.

J. Agardh, Linnæa Bd. 15 p. 453, Spec. II, p. 419, III p. 508; Harvey, Phyc. Brit. pl. 36; Bornet et Thuret, Rech. féc. Florid., Ann. sc. nat. Vesér. t. 7, 1867 p. 141, pl. 11 fig. 1—5; Janczewski (1877) p. 113, Plate 3 fig. 3; Wille, Ueber die Befrucht. bei Nemat. multif., Ber. deut. bot. Ges. 1894 p. 57; Grace D. Chester, Notes concerning the development of *Nemalion multifidum*, Botan. Gazette Vol. 21, 1896 p. 340 Pl. XXV and XXVI; J. J. Wolfe, Cytolog. Stud. on *Nemalion*, Annals of Botany, Vol. 18, Oct. 1904; Oltmanns (1904) p. 539, 540, 542.

Rivularia multifida Weber et Mohr, Naturhist. Reise 1804 p. 193 Taf. III fig. 1.

Chordaria multifida Lyngb. Hydr. p. 51; Flora Dan. Tab. 1669.

As to the structure of the frond reference may be made to the descriptive works and the paper of GRACE D. CHESTER. The ramification is said to be dichotomous and it may possibly be so, but it may also be lateral, as shown in fig. 68 A, representing a young plant. The structure of the cells has been studied by WOLFE, from whose statements it appears that the presumed pyrenoid is not a true pyrenoid but a vacuolar cavity without organized contents. While the chromatophore is in general stellate, I found it in a basal disc globular without branches given off towards the periphery of the cell.

As stated by Miss CHESTER the germinating spores develop at first into short branched, creeping filaments consisting of short rounded cells. Later on filaments

composed of long, narrow cells with less protoplasmic contents are developed in the continuity of the primary ones. They form later at their upper end fasciculated branches reminding one of the peripheral assimilative filaments in the older frond. The author named supposes that such thin erect filaments may meet and twist together, thus giving rise to an erect frond. I have not observed the species in this stage of development. In February at Gilleleje I found crusts apparently formed by densely united creeping filaments like those described by Miss CHESTER, but almost no erect filaments were observed. Young plants with the normal structure are shown in fig. 68; the assimilative filaments were only less numerous in the lower part of the plants than later.

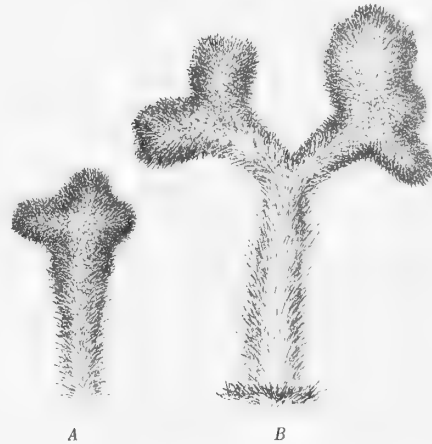


Fig. 68.

Nemalion multifidum. Young plants from the mole at Gilleleje, November 1902. C. 33:1.

The assimilative filaments terminate in hyaline hairs of various length, generally rather short. The shortest are almost entirely filled with protoplasm, while in the longer the protoplasm with the nucleus is concentrated in the upper end, the rest of the cell containing only a thin parietal layer. When a hair dies a new one is often formed at the same place from the subjacent cell; the lower part of the old membrane remains however surrounding the base of the new hair as a sheath. A new hair may also be formed beside and below the terminal one, and this may also be renewed (fig. 69).

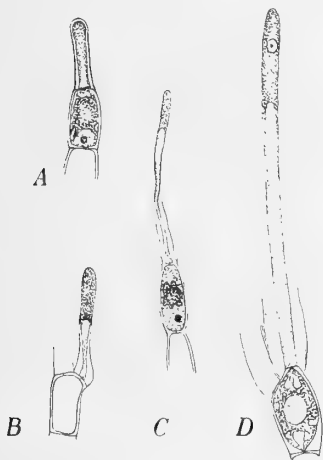


Fig. 69.

Nemalion multifidum. End-cells of assimilative filaments with hairs; in D the nucleus is visible. 630:1.

The antheridial branches form clusters at the ends of the assimilative filaments as described by BORNET and THURET (1867) and WOLFE. Each cell in the antheridial branch gives rise to four antheridia or fewer (fig. 70). The spermatogenesis has been worked out by WOLFE.

The carpogenic filaments are terminal on the assimilative filaments and usually 3-celled, (according to WOLFE 2- to 5-celled). Concerning the fertilization and the development of the cystocarp reference may be made to the quoted papers of BORNET and THURET, JANCZEWSKI, SCHMITZ, WILLE and WOLFE. The fertilised carpogonium divides by a transverse wall into a basal or placental cell, remaining undivided, and an upper cell dividing by vertical walls into a number of cells giving rise to branched sporogenous filaments, the end-cells of which produce carpospores.

The species occurs in all the Danish waters except the Baltic, growing in the littoral region, thus being out of the water at low-tide. It varies but little in shape in the different localities; it attains very often a length of ca. 20 cm., but larger specimens not seldom occur; thus specimens measuring 40 cm. were met with at Harboøre and Gilleleje. It has been found in the months July to November; in the remaining part of the year it is probably represented by the creeping filaments described by Miss CHESTER which were, as mentioned above, observed by me in February. It may be supposed that the germination takes place immediately after the setting free of the spores but that the erect plants only develop in the next summer. I found however in November on the mole at Gilleleje young plants from less than 1 mm. to a few cms. in length; they would probably have perished during the winter, but possibly the basal portions would have been able to produce new erect fronds.

The species is said to be as a rule monoecious; I found it however most frequently dioecious in the Danish waters. In the proportionally few monoecious specimens (about 10 per cent) I found the two kinds of sexual cells near to each other in all parts of the plant and there is thus no reason to believe that the dioecious specimens would have proved to be really monoecious on closer examination. Antheridia occur in all the months July to November, but in the last months they are in a great measure emptied. Ripe cystocarps may occur already in July; in August a great part of the spores are often set free as well as later, in November however cystocarps containing most of the spores may still be found.

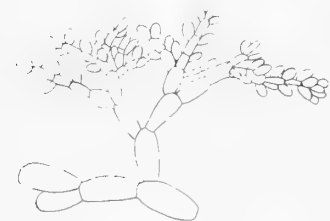


Fig. 70.

Nemalion multifidum. Antheridial branches at the ends of assimilative filaments. 340:1.

In autumn or the beginning of the winter the plants gradually die, the assimilative filaments being the first destroyed. This may begin already in August, but on the other hand fairly well-kept specimens are to be found still in November.

The species prefers agitated water; it therefore grows on the outer, not on the inner sides of the moles. It occurs on stones but also on wood, often together with *Fucus*.

Localities. Ns: Groins at Harboøre and Thyborøn. — Sk: Hanstholm, on a boulder near land; Lønstrup (Warming); Hirshals (!, Børgs.); Skiveren, on wreck. — Lf: Odde-sund; Struer; Ejerslev Røn. — Kn: Frederikshavn; harbour of Vesterø, Læsø; Hornex, Læsø (J. P. Jacobsen). — Ke: Gilleleje (Lyngb., !). — Km: Anholt harbour; Herringholm (Lyngbye). — Ks: Grenaa harbour; Tisvilde (C. Rasch); near Klintebjerg, Odsherred (J. Vahl); Isefjord; Nykøbing; Lynæs; off Nordskov; Ourø; Holbæk Fjord; Bramsnæs Vig. — Sa: Kyholm, in the middlemost *Fucus*-zone; Sælvig (Hjalmar Jensen); Koldby Kaas; Hofmansgave (Hofm. Bg., Lyngb., C. Rosenb.); Juelsminde. — Lb: Bogense. — Sf: Rødløk Grund off Nakkebølle Fjord; Svendborg; Birkholm; Rudkøbing. — Sb: Kerteminde; Korsør; Lohals. — Sm: Guldborg. — Su: Hellebæk; Helsingør; Humlebæk (Henn. Petersen); near Hveen (Ørsted); Trekroner near Copenhagen (Ørsted).

Helminthocladia J. Agardh.

1. *Helminthocladia purpurea* (Harv.) J. Ag.

J. Agardh, Spec. II, p. 414, III, p. 506; Flora Danica tab. 2699; Schmitz, Chromatophoren der Algen, p. 63 fig. 11—12.

Mesogloia purpurea Harvey in Hooker Brit. Flora II, 1833, p. 386.

Nemalion purpureum Chauv.; Harvey, Phyc. Brit. Pl. 161; Kützinger, Tab. phyc. 16. Band Pl. 62 c, d.

The structure of the frond is somewhat similar to that of *Nemalion multifidum*, but the assimilative filaments are composed of larger cells, of which the terminal ones are the largest (fig. 71). These terminal cells bear no hairs, and these organs are upon the whole rare in the older parts of the plants, while they occur fairly abundantly in the younger parts. They are given off from thinner branches not reaching the surface of the frond and are partly terminal, partly lateral; they have the same structure as other similar hairs, are fairly thick and attain a considerable length (fig. 71 A, B). Besides the hair a little cell with fairly dense contents is visible; such cells are also to be found in the older parts of the frond without hairs. The chromatophores which are particularly large and well developed in the terminal club-shaped cells, contain as shown by SCHMITZ (l. c.) a large central pyrenoid which in some cases was readily visible as a dense body, while in other cases they conveyed rather the impression of being vacuolar cavities like those stated for *Nemalion* by WOLFE (figs. 71 A, 72 A, B).

The antheridia form dense, often hemispherical clusters at the end of the assimilative filaments. The outermost cells are then small and bear a number of short much branched antheridia-bearing branchlets. These branchlets are shorter than in *Nemalion* and *Helminthora* and their joints are often nearly globular (fig. 72 A—C). In some cases a number of globular cells were found crowded together at the upper end of the last cells in the assimilative filaments (fig. 72 E, F). These cells, which were larger than the antheridia and contained a thin chromatophore, might be suggestive of monosporangia; they were however certainly no such organs but probably only checked antheridial branches,



[Fig. 71.

Helminthocladia purpurea. A, end of assimilative filament with young hair. B, similar with base of hair. C, young 4-celled carpogonic filament. D, assimilative filaments with antheridia and carpogonic filament. E, end of branch with a terminal 4-celled and a lateral 2-celled carpogonic filament. F, carpogonic branch in stage of fertilization. 350:1.

which had not produced antheridia. The case represented in fig. 72 *D* goes to prove the correctness of this interpretation.

The carpogenic filaments are, as stated by SCHMITZ and HAUPTFLEISCH (1896 p. 333), lateral on the assimilative filaments and consist usually of 3 cells, the lowest of which is often wedge-shaped (fig. 71 *D, F*), 4-celled carpogenic filaments however also occur (fig. 71 *C*). Only once have I seen a carpogenic filament terminal on a vegetative filament which bore also a 2-celled lateral carpogenic filament (fig. 71 *E*). After fertilization the carpogonium is not divided, as in *Nemalion* and *Helminthora*, by a transverse wall into a stalk-cell and an upper cell producing the sporogenous filaments, but it divides by an oblique wall going from the upper side of the

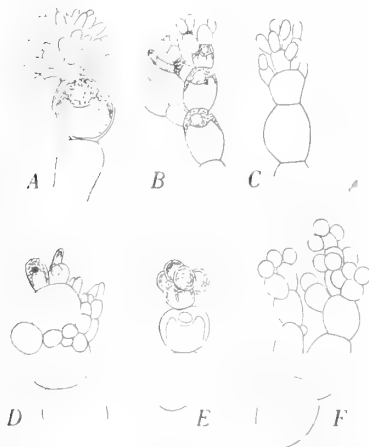


Fig. 72.

Helminthocladia purpurea. A—C, ends of assimilative filaments with clusters of antheridia. D, checked antheridial branches which have developed only very few antheridia. E, F, ends of filaments bearing globular cells, probably sterile antheridial branchlets. A—D 560:1, E—F 350:1.

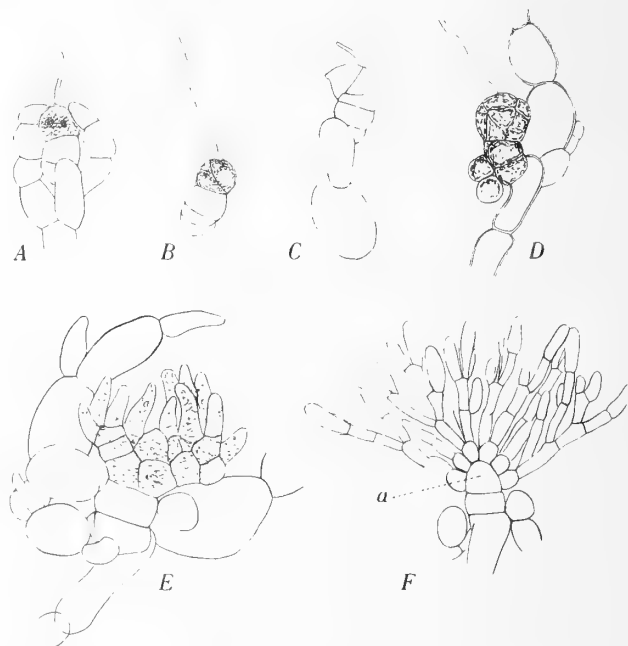


Fig. 73.

Helminthocladia purpurea. A, fertilized carpogonium, still undivided but with divided nucleus. B, fertilized carpogonium divided by an oblique wall. C, similar stage, the one daughter-cell appears about to divide. D, more advanced stage. E, the sporogenous filaments begin to grow out. F, median section of ripe cystocarp. A—D, F 350:1, E 560:1.

cell to the margin of the basal wall (fig. 73 *B, C*) and thereafter follows variously orientated walls, giving as result a cell-complex growing out into numerous radiating, branched sporogenous filaments, the end-cells of which produce carpospores. The succession of the divisions in the carpogonium I have not been able to follow; they seem to take place in such a manner that a number of peripheral cells are cut off while a larger placental cell remains in the centre (fig. 73 *F, a*). The sporogenous filaments are rather long-celled, the mother-cells of the carpospores long and narrow. After the discharge of the carpospore a new mother-cell may be produced by proliferation from the subterminal cell. At the time when the divisions

of the carpogonium begin the sterile cells in the carpogenic filament and the nearest-lying cells in the supporting filament give off branches forming an involucre round the young cystocarp. The ripe cystocarp is a somewhat flattened capitulum, the filaments of which radiate outwards and to the sides.

All the specimens examined were monoecious. The largest specimens were 57 cm. long.

The species has only been found on the Skagerak coast, either washed ashore or in a seine, and no certain information can therefore be given as to the conditions under which it occurs. At Skagen I took it in a seine fishing in ca. 7 to 9 meters depth, and at Løkken I found it on the beach attached to *Lithothamnium* washed ashore. Probably it grows near the land in relatively small depths. It has only been met with in August and the beginning of September.

Localities. **Sk:** Tværsted (M. L. Mortensen), washed ashore; Løkken; 2 miles W. of Skagen, on the beach (Caroline Rosenberg Sept. 1st 1859); in a seine off the Marine Hotel on Skagens Gren, 7—9 met.

Helminthora J. Agardh.

1. *Helminthora divaricata* (Ag.) J. Agardh.

J. Agardh Spec. II p. 416, III p. 507; Bornet et Thuret, Féc. Flor. p. 142 Pl. 11 fig. 7; Janczewski (1877) p. 114 Pl. 3 fig. 4—6; Thuret, Études phycolog. p. 63 Pl. 32.

Mesogloia divaricata Ag. Syst. Alg. p. 51.

Mesogloia Hornemanni Suhr, Flora Dan. tab. 2202 (?).

Of this species, which is easily recognizable from the two foregoing species by its distinctly limited inner axis giving off the assimilative filaments, I have only had very little material from Danish waters; I shall therefore content myself with referring to the above quoted works, in particular those of JANCZEWSKI and THURET.

The species has only been found in one locality and was represented only by two slightly developed specimens; the largest measuring 5,5 cm. in length was not much branched and bore numerous antheridia. They both grew on *Polyides rotundus*¹.

Locality. **Kn:** TL, W. of Nordre Rønner, 4—5,5 meters, September.

Fam. 3. Chætangiaceæ.

Scinaia Bivona.

1. *Scinaia furcellata* (Turn.) Biv.

J. Agardh Spec. I, p. 422, II p. 512; Bornet et Thuret, Not. alg. I p. 18, Pl. VI; Schmitz, Befrucht. 1883, p. 15, Taf. V fig. 5—7; Schmitz and Hauptfleisch, Rhodophyc. p. 337; Oltmanns, Morph. I p. 556.

Ulva furcellata Turner in Schrader, Journal für Botanik 1800 p. 301.

Ginnania furcellata (Turn.) Mont.; Harvey, Phyc. Brit. Pl. 69.

¹ When the printing of this paper was almost finished, L. KURSSANOW has published interesting investigations on the cytology of the three last-named genera of Helminthocladiaceæ (Beiträge zur Cytologie der Florideen. Flora 99. Bd., 4. Heft 1909, p. 311), but further reference could not be made to them here.

Two specimens of this widely distributed species, the occurrence of which on the shores of Europe extends from the Mediterranean to Scotland and Helgoland, were found washed ashore at Løkken. As they were quite fresh and were attached to a fragment of an acorn shell, they must undoubtedly have grown near the place where they were found. They attained a length of 6,5 cm. and contained ripe and unripe cystocarps. Small antheridial groups were also found on the surface of the frond. As to the structure of the frond and the structure and development of the fruit I have no new observations; reference may be made to the above quoted papers, in particular those of BORNET and THURET, and SCHMITZ. The species is easily recognizable by its soft, cylindrical, dichotomous frond having a thin solid axis and by the characteristic, immersed cystocarps provided with a dense fruit-wall.

Locality. Sk: Washed ashore at Løkken, August.

CORRIGENDA.

- P. 9, l. 9 from top, for "Antithammion" read "Antithamnion", for "Lithothamion" read "Lithothamnion".
- P. 56, l. 8 from top, for "cushon" read "cushion".
- P. 80, l. 5 from top, should read "Fam. 2".
- P. 88, l. 14 from top, for "egrediunt" read "egrediuntur".
- P. 91, l. 11 from top, for "egrediunt" read "egrediuntur".
- P. 97, l. 6 from bottom, for "egrediunt" read "egrediuntur".

EXPLANATION OF PLATES.

All figures are photographs after dried specimens, about $\frac{4}{5}$ nat. size.

Plate I.

Porphyra umbilicalis (L.) J. Ag.

1. Monoecious specimen showing a longitudinal limiting line between the male and the female part of the frond. (Helsingør, September).
2. Small male specimen (f. *laciniata*); the marginal zone has produced antheridia. (Helsingør, September).
3. Female plant. The fertile zone above shows irregularly ramified spots caused by earlier maturation of the cystocarps here than in the surrounding parts. (Nørre Sundby, Limfjorden, September).

Plate II.

- 1—3. *Porphyra umbilicalis* (L.) J. Ag. f. *linearis* (Grev.). 1, monoecious, 2, female, 3, male specimen (Frederikshavn, December—January).
- 4—13. *Porphyra leucosticta* Thur.
- 4—7. Sexual plants, (harbour of Skagen, April 1905, M. L. Mortensen).
8. Asexual plant, possibly producing gonidia, (harbour of Skagen, July 1907).
- 9—13. Small specimens being the under part of specimens which have exhausted their spermatia and carpospores, (harbour of Skagen, July 1905).



1



2



3

Porphyra umbilicalis (L.) J. Ag.



1—3 *Porphyra umbilicalis* (L.) J. Ag. f. *linearis*. 4—13 *Porphyra leucosticta* Thur.

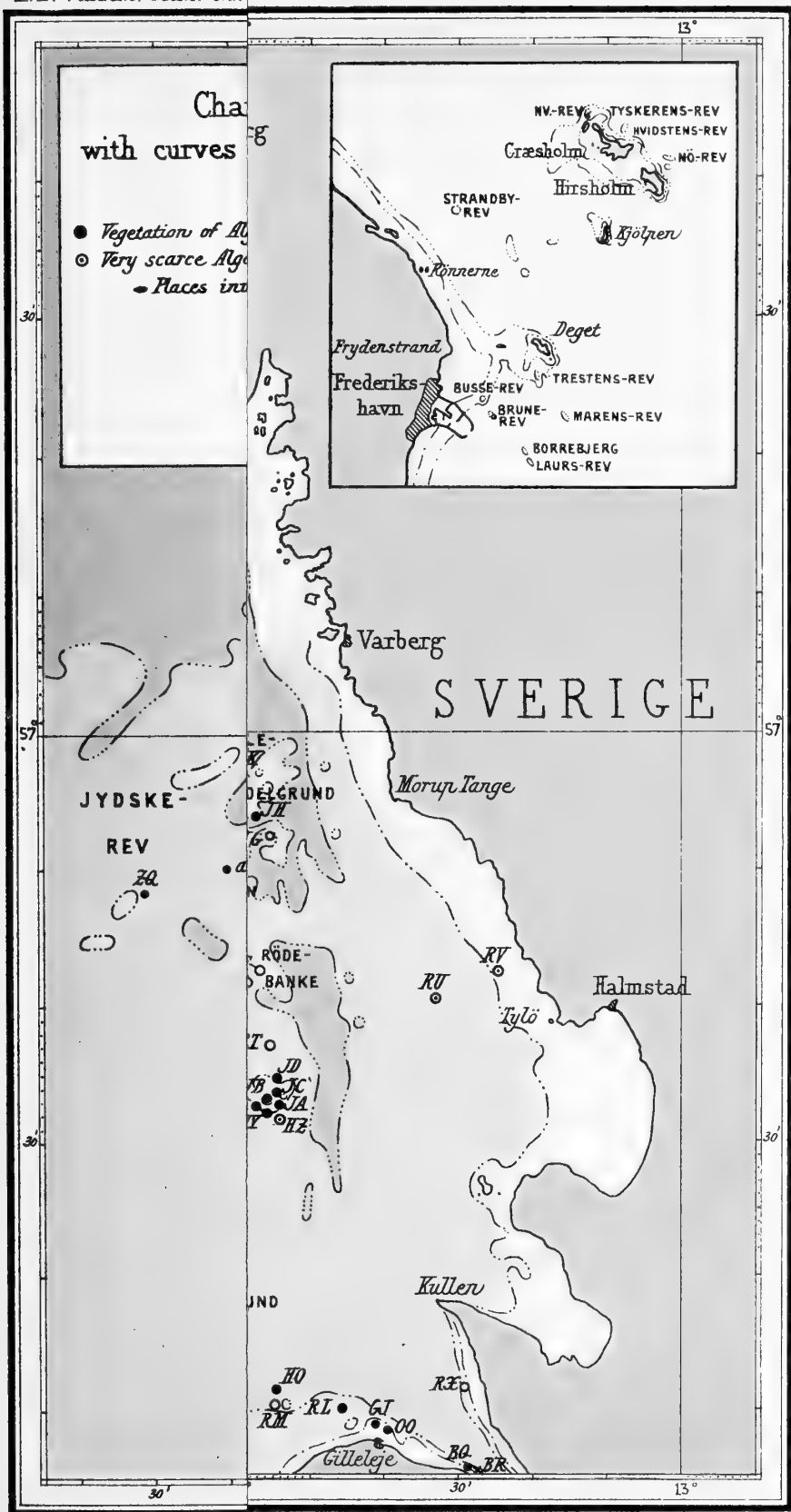
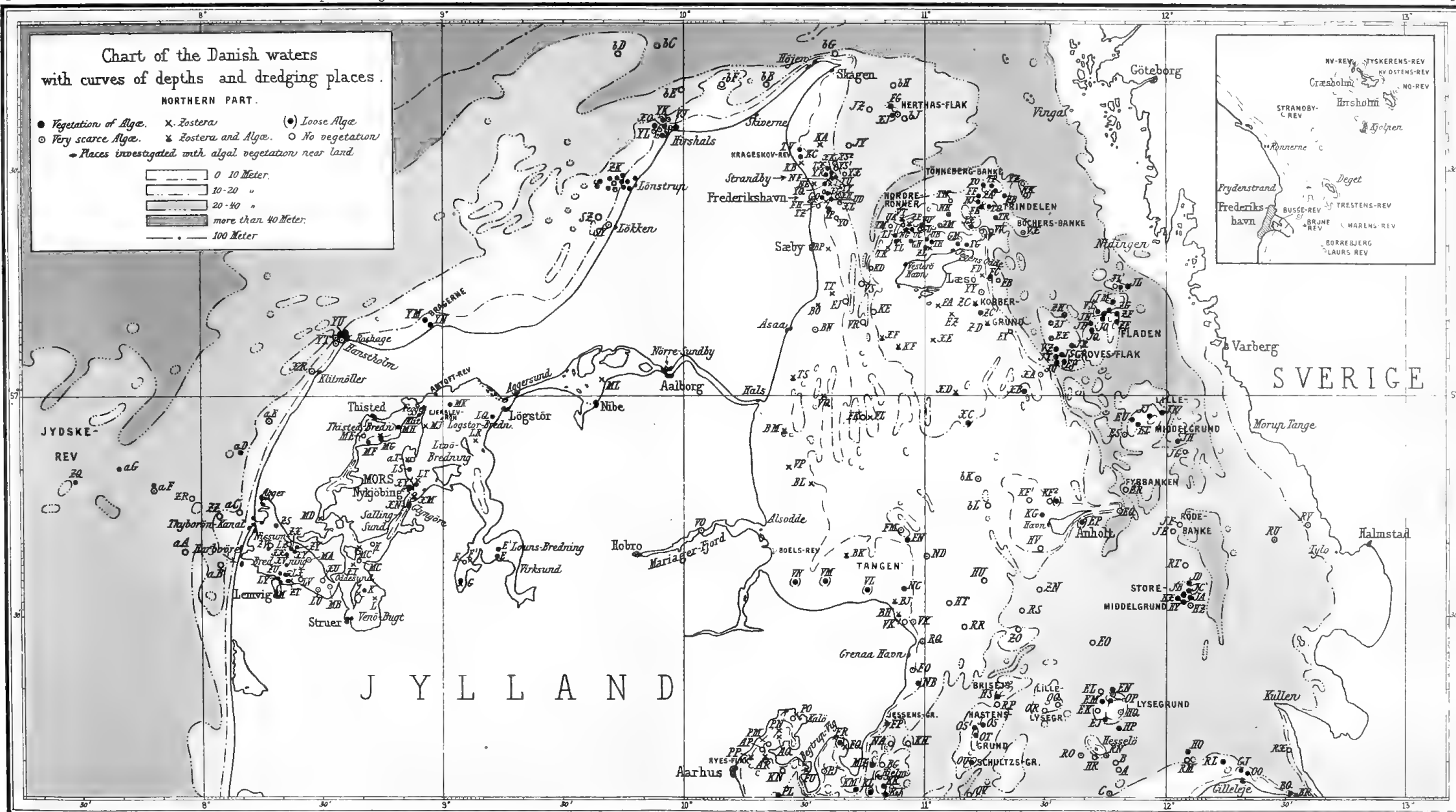
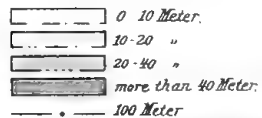


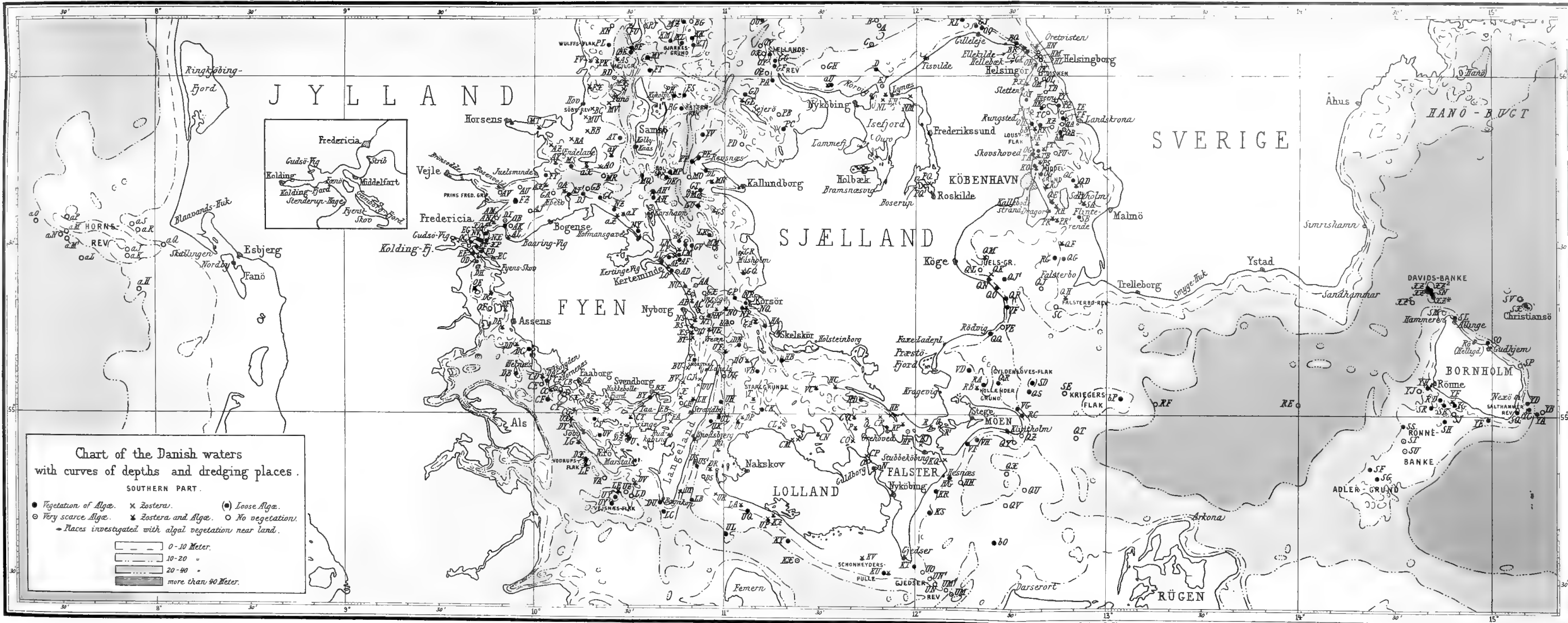
Chart of the Danish waters with curves of depths and dredging places.

NORTHERN PART.

- Vegetation of Algae. x Zosteræ. (○) Loose Algae.
○ Very scarce Algae. x Zosteræ and Algae. ○ No vegetation.
• Places investigated with algal vegetation near land.







THE MARINE ALGÆ OF DENMARK

CONTRIBUTIONS TO THEIR NATURAL HISTORY

PART II

RHODOPHYCEÆ II.

(CRYPTONEMIALES)

BY

L. KOLDERUP ROSENVINGE

WITH TWO PLATES

D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, 7. RÆKKE, NATURVIDENSK. OG MATHEM. AFD., VII. 2

KØBENHAVN

HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL

BIANCO LUNOS BOGTRYKKERI

1917

Det Kgl. Danske Videnskabernes Selskabs Skrifter, 6^{te} Række.

Naturvidenskabelig og mathematisk Afdeling.

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I, med 42 Tavler, 1880—85	29. 50.
1. Prytz, K. Undersøgelser over Lysets Brydning i Dampe og tilsvarende Vædsker. 1880	65.
2. Boas, J. E. V. Studier over Decapodernes Slægtskabsforhold. Med 7 Tavler. Résumé en français. 1880	8. 50.
3. Steenstrup, Jap. Sepiadarium og Idiosepius, to nye Slægter af Sepiernes Familie. Med Bemærkninger om to beslægtede Former Sepioloidea D'Orb. og Spirula Lmk. Med 1 Tavle. Résumé en français. 1881	1. 35.
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5. Boas, J. E. V. Om en fossil Zebra-Form fra Brasiliens Campos. Med et Tillæg om to Arter af Slægten Hippidion. Med 2 Tavler. 1881	2. "
6. Steen, A. Integration af en lineær Differentialligning af anden Orden. 1882	50.
7. Krabbe, H. Nye Bidrag til Kundskab om Fuglenes Bændelorme. Med 2 Tavler. 1882	1. 35
8. Hannover, A. Den menneskelige Hjernes kals Bygning ved Anencephalia og Misdannelsens Forhold til Hjernes kalls Primordialbrusk. Med 2 Tavler. Extrait et explication des planches en français. 1882	1. 60.
9. — Den menneskelige Hjernes kals Bygning ved Cyclopia og Misdannelsens Forhold til Hjernes kalls Primordialbrusk. Med 3 Tavler. Extrait et explic. des planches en français. 1884	4. 35.
10. — Den menneskelige Hjernes kals Bygning ved Synotia og Misdannelsens Forhold til Hjernes kalls Primordialbrusk. Med 1 Tavle. Extrait et explic. des planches en français. 1884	1. 30.
11. Lehmann, A. Forsøg paa en Forklaring af Synsvinklens Indflydelse paa Opfattelsen af Lys og Farve ved direkte Syn. Med 1 Tavle. Résumé en français. 1885	1. 85.
II, med 20 Tavler, 1881—86	20. "
1. Warning, Eug. Familien Podostemaceae. 1 ^{ste} Afhandling. Med 6 Tavler. Résumé et explic. des planches en français. 1881	3. 15.
2. Lorenz, L. Om Metallernes Ledningsevne for Varme og Elektricitet. 1881	1. 30.
3. Warning, Eug. Familien Podostemaceae. 2 ^{den} Afhandling. Med 9 Tavler. Résumé et explic. des planches en français. 1882	5. 30.
4. Christensen, Odn. Bidrag til Kundskab om Manganets Ilter. 1883	1. 10.
5. Lorenz, L. Farvespredningens Theori. 1883	60.
6. Gram, J. P. Undersøgelser ang. Mængden af Primittal under en given Grænse. Résumé en français. 1884.	4. "
7. Lorenz, L. Bestemmelse af Kviksølvsejlers elektriske Ledningsmodstande i absolut elektromagnetisk Maal. 1885	80.
8. Traustedt, M. P. A. Spolia Atlantica. Bidrag til Kundskab om Salperne. Med 2 Tavler. Explic. des planches en français. 1885	3. "
9. Bohr, Chr. Om Iltens Afvigelser fra den Boyle-Mariotteske Lov ved lave Tryk. Med 1 Tavle. 1885	1. "
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6. — Kritiske Studier over nogle Tandhvaler af Slægterne <i>Tursiops</i> , <i>Orca</i> og <i>Lagenorhynchus</i> . Med 2 Tavler. Résumé en français. 1887	4. 75.
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1. Lütken, Chr. Spolia Atlantica. Bidrag til Kundskab om de tre pelagiske Tandhval-Slægter <i>Steno</i> , <i>Delphinus</i> og <i>Prodelphinus</i> . Med 1 Tavle og 1 Kort. Résumé en français. 1889	2. 75.
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THE MARINE ALGÆ OF DENMARK

CONTRIBUTIONS TO THEIR NATURAL HISTORY

PART II

RHODOPHYCEÆ II.

(CRYPTONEMIALES)

BY

L. KOLDERUP ROSENVINGE

WITH TWO PLATES

D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, 7. RÆKKE, NATURVIDENSK. OG MATHEM. AFD., VII. 2



KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1917

III. Cryptonemiales.

Fam. 4. Dumontiaceæ.

Dumontia Lamour.

1. *Dumontia incrassata* (O. F. Müll.) Lamour.

Lamouroux, Essai. Mus. d'hist. nat. Paris 1813; Batters, Catalogue, 1902, p. 93.

Ulva incrassata O. Fr. Müller, Flora Danica tab. 653, 1775.

Ulva spongiformis O. Fr. Müller, Flora Danica tab. 763 fig. 2, 1778(?). Fragment not determinable with certainty.

Ulva filiformis Hornemann, Flora Danica tab. 1480, 2, 1813.

Gastridium filiforme Lyngbye, Hydr. p. 68 tab. 17.

Gastridium filiforme var. *intestiniformis* Liebman, Flora Danica tab. 2457, 1845 = f. *crispata* Grev.

Dumontia filiformis (Hornem.) Greville, Alg. Brit. p. 165 tab. 17 (cystocarp); Harvey, Phyc. Brit. pl. 59 and 357 B; Nägeli, Die neueren Algensysteme 1847, p. 243 Taf. IX fig. 4—8 (structure of frond); J. Agardh, Spec. II p. 249, III p. 257; Kützing, Tab. phyc. 16. Band Taf. 81 (transverse section of tetraspore-bearing plant); Schmitz, Befr. Flor. 1883 p. 18, 20, fig. 22 (carpogonial filament); Reinke, Algenflora d. westl. Osts. p. 26; G. Brebner, On the Origin of the filamentous thallus of *Dumontia filiformis*. Journ. Linn. Soc. Bot. Vol. 30, 1895, p. 436; Kuckuck, figure of a young basal disc in Oltmanns' Morph. I, p. 573; Okamura, Icones of Jap. Alg. Vol. I No. IV pl. 16 figs. 1—8, p. 65.

The fronds arise from a crustaceous disc produced by the germinating spore. A 5 days old plant is shown in fig. 74 A. It is not much larger than the tetraspore from which it arose, but it is divided into a number of small cells and has become a hemispherical body from the border of which short one- or two-celled filaments proceed.¹ A later stage is figured by KUCKUCK (OLTMANN'S l. c.); a group of short-celled filaments is here seen given off from the upper side of the disc, and it is said that only one of these filaments serves to form the erect frond, some of the others forming the bark on the base of it. The basal discs may be perennial (REINKE, BREBNER); they form large expansions on stones, *Mytilus*, *Chondrus* a. o. In sunny localities they have a light violaceous colour and often show radial folding (in a dried state), in greater depths they are darker. They are easily distinguishable by their structure and by the occurrence of groups of short-celled filaments giving rise to new erect fronds. As shown by BREBNER (l. c.) the fronds may be endogenous

¹ The germination of the tetraspores has quite recently been described by KYLIN (Über die Keimung der Florideensporen. Arkiv för Botanik. Band 14. No 22. Stockholm 1917, p. 9). The author kept the sporelings in culture during more than two months but did not obtain any production of erect shoots. The sporelings produced after 10 days long unicellular hairs, but after addition of nitrate to the culture no hairs were produced.

or exogenous and, according to this author, the cells of the short-celled filaments are divided by intercalary divisions.

The structure of the frond has been described in 1847 by NÆGELI (l. c.). It terminates in an apical cell which is said to be divided by oblique cell-walls producing segments at all sides, and this is affirmed by SCHMITZ and HAUPTFLEISCH (ENGLER u. PRANTL, Nat. Pflfam. I, 2 p. 517); it is however at least not general. The young fronds arising from the basal disc have at all events an apical cell divided by horizontal parallel walls, and this is also the case with young slender branches (fig. 74, B, C). In thicker shoots still in development I have found the segment walls

somewhat inclined, but not so much that they reached the foregoing segment wall (fig. 24, C). The cells of the frond contain a single nucleus and a number of disc-shaped chromatophores.

Some of the surface-cells may produce a hyaline hair of the same character as in other Florideæ (fig. 74, D). In spring (March to May) they are most developed, numerous, long and rich in protoplasm; at other seasons they are often wanting.

The frond is at first cylindrical, but in an advanced age it becomes irregularly compressed and crisped (f. *crispata* Grev.).

In winter and in shaded

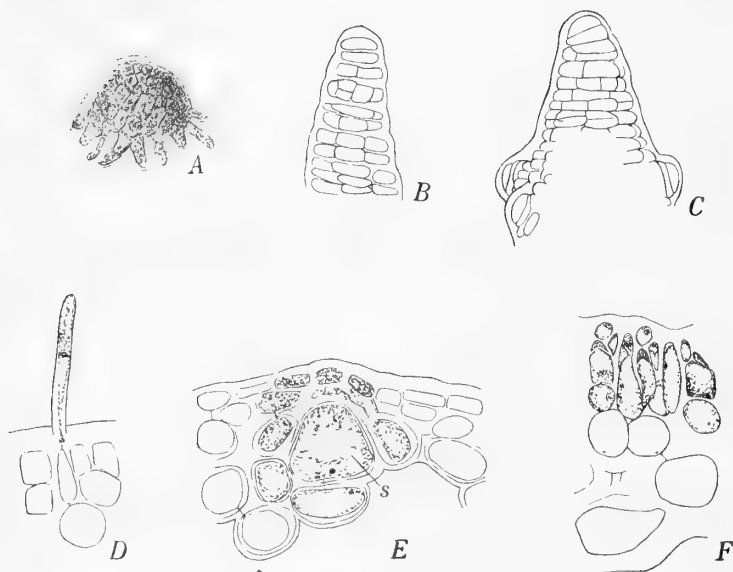


Fig. 74.

Dumontia incrassata. A, five days old plant from germinating tetraspore. B, upper end of side branch showing transverse segment walls. C, tip of young frond (November), the segment walls in the main axis slightly inclined. D, young hair. E, transverse section of frond showing a young sporangium. F, transverse section of frond showing the development of the antheridia.

A 300:1. B, C, E 390:1. D, F 630:1.

localities it is dark red-brown, while in sunny places in spring and summer it has a light yellowish colour, the tips at last becoming green.

The central cavity contains a thin slimy matter which seems to consist of pectic substances; it forms a network in the cavity, the meshes containing probably only water.

The sporangia are, as is well known, immersed in the wall of the frond; they are born of a cell in the inner cortex bearing moreover at least two cortical filaments (comp. KÜTZING Phyc. gen. tab. 74 II). The sporangium is connected through a pit with the bearing cell but not with other of the cortical cells (fig. 74, E); thus it is terminal and not intercalary as in *Dilsea*. The division is always cruciate; but

it is often somewhat irregular, the longitudinal walls being inclined. I have not been able to decide if real cell-walls are formed between the spores in the sporangium. The latter is surrounded with a distinct wall consisting of more than one layer; at the lines of separation between the spores the inner layer is seen to be continuous, without penetrating between the spores. The sporangia develop in the main axis as well as in the branches down to 1 to 2 cm. from the base.

The antheridia (spermatangia) form a continuous layer on almost the whole surface of the male individuals. They are cut off by inclined, often upwards convex, intersecting walls of the upper end of the antheridia-bearing cells (SVEDELIUS' spermatangial mother-cells), at two (or perhaps more than two) sides (fig. 74, *F*). The form of the antheridia-bearing cells is rather variable according to the varying length and breadth; they contain a single nucleus but seem to be destitute of chromatophores. Beneath a fully developed antheridium a new one can arise, a little cell very rich in contents being cut off in the same direction as the former. In the middle of fig. 74 *F* above, the oldest antheridium is seen to be connected through a pit with the youngest one formed right under it. The continued formation of antheridia thus takes place by intercalary divisions, and the antheridia are placed in two (or more) series, but owing to the evacuation of the spermatia, at most two antheridia are to be seen at the same time in the same series. The antheridial development in this plant thus does not correspond with any of the types set up by SVEDELIUS (*Martensia*, K. Sv. Vet. Ak. Handl. Band 43. No. 7. 1908 p. 76).

The development of the cystocarp was found to agree with what OKAMURA found in examining Japanese specimens. The carpogonial branches arise from the inner part of the wall of the hollow frond, frequently from a cell in a longitudinal filament or from a cell given off from it. They are 5-celled and curved, in particular at the upper end, where the carpogonium is cut off by an oblique wall intersecting the underlying wall (comp. SCHMITZ l. c. fig. 22, OKAMURA l. c. fig. 4).

The auxiliary-cell filaments, being very numerous, as the carpogonial filaments as well, have a similar position to these. They are somewhat curved, and consist of 4 to 5, more rarely 6, rather low cells with rich contents. They are frequently placed quite near the carpogonial filaments; it may even happen that a carpogonial filament arises from the base of an auxiliary-cell filament (fig. 75 *A*). After fecundation, fusions take place between the carpogonium and one or more cells in the carpogonial filament, resulting in the formation of a great fusion-cell of very irregular form, giving off sporogenous filaments in various directions; in fig. 75 *E* 4 such filaments are present. The auxiliary cells with which they become connected are usually the second cell from the base of the auxiliary-cell filaments, sometimes the third or even the fourth cell. After fusion, the auxiliary-cell, when giving rise to a cystocarp, produces, at the convex side of the filament, a number of cells which after several divisions form a group of carpospores placed around a placental cell originating from the auxiliary cell (or the fusion cell). A curious anomaly is shown in fig. 75 *F*. In the ventral part of the carpogonium no nucleus was visible, but



Fig. 75.

Dumontia incrassata. A, two carpogonial branches, the upper representing a side branch of an auxiliary-cell filament. B, carpogonial branch; the carpogonium does not reach the third cell from the top. C, carpogonial branch and auxiliary-cell branch. D, carpogonial filament after fecundation; the fertilized carpogonium has fused together with the three uppermost cells of the carpogonial branch, has become very enlarged and formed sporogenous filaments. E, the fertilized carpogonium has fused with one or two cells of the carpogonial filament and has given rise to four sporogenous filaments. At right a four-celled auxiliary-cell filament; the auxiliary-cell after having fused with a sporogenous filament has produced a young gonimoblast. F, the trichogyne of the unfertilized carpogonium contains two nuclei, while the ventral part contains no nucleus. The lowest or second cell from the base has fused with a sporogenous filament from another carpogonium. G, auxiliary-cell filament; the auxiliary cell has fused with a sporogenous filament and produced a new sporogenous filament. H, auxiliary-cell filament with young cystocarp. I, transverse section of frond with ripe cystocarp. a, auxiliary cell. af, auxiliary-cell filament. s, sporogenous filament. t, trichogyne. A, B, D, E, G, H 380:1 C, F 610:1. I 220:1.

in the middle of the trichogyne two bodies were found which were probably nuclei. As no spermatia were found fixed to the trichogyne, the two nuclei must have derived by division from the original carpogonial nucleus, the undermost representing probably the sexual nucleus, the upper the trichogynal nucleus. It must however be admitted that the upper end of the trichogyne was not quite distinctly visible. This filament is further remarkable in that the second cell from the base acts as an auxiliary cell, having fused with a sporogenous filament from another carpogonium. It is however not fully clear if the great fusion cell has arisen from the second cell or by division from the first cell, which is rather small and half enclosed by it. In the first case the carpogonial filament has been 6-celled.

The species is widely distributed on the Danish coasts, and occurs often abundantly. It grows particularly in somewhat sheltered localities, and attains there the greatest dimensions. In **Sk**, **Lf**, **K**, **Sa**, **Lb** and **Sf** it has been found only at low-water mark or a little lower; on the other hand, in the southern and eastern waters (southern parts of the Great Belt and of the Sound and the Baltic) it has also been met with in depths of 4 to 12 meters, and it occurs in a similar manner in the western Baltic according to REINKE (l. c.), while it otherwise appears to grow only at a slight depth. On the shores of North Europe it grows, where tide occurs, in the middlemost part of the littoral region ("à mi-marée"). The explanation of this peculiar distribution in the western Baltic and the adjacent waters might perhaps be sought in the lesser salinity of these waters. It deserves to be mentioned in this connection that the species, according to CROUAN (Fl. Finist. p. 144), in the neighbourhood of Brest occurs particularly where fresh water runs out. When growing at low-water mark in Danish waters of comparatively high salinity, the plants are also temporarily exposed to fresh water at least by rainy weather during low-water. On the other hand it will be seen from the following maximal lengths for specimens collected in a series of localities in the Sound ranged from North to South that the length decreases with much decreasing salinity: Hellebæk 47 cm, Humlebæk 30 cm, Sletten 28 cm, Trekroner (Copenhagen) 20 cm, Dragør 8 cm. These specimens were all collected near the low-water mark. A length of over 50 cm has been met with in specimens from **Lb**, **Sf** (70 cm) and **Sb**. In the other waters the following maximal lengths have been recorded: **Sk** 37, **Lf** 28, **K** over 30, **Sa** 40, **Su** 47 cm.

The species has been found with erect fronds at all seasons, but only abundantly in the first half of the year, from the middle or the end of the winter to the beginning of the summer. Most of the specimens die in June or July; only single, rare specimens are therefore met with in the more advanced summer and in autumn. As the spores germinate easily immediately after having been shed, the species must be supposed to endure the summer in a crustaceous form, originating for the most part from the spores shed in the last spring but partly also of older date. The sexual organs have been met with in winter and spring and in September, ripe cystocarps in May to July, ripe tetrasporangia in May to July, once even in August

(Sk). Sexual organs and tetrasporangia occur always in distinct specimens. The same is the case with the antheridia and the carpogonia; I have found, however, some few specimens which seemed to be monoecious, but the supposed antheridia were not fully developed.

Localities. **Sk**: Lønstrup (loose on the shore); Hirshals, mole and reef. — **Lf**: Oddesund; Nykøbing (Th. Mort., F. Børg. !); Glyngøre; Agersund (Th. M.); Aalborg (Th. M.); Hals (F. Børg.). — **Kn**: Hirsholm; Køpen; Frederikshavn; Nordre Rønner. — **Km**: Anholt, harbour. — **Ks**: Harbour of Grenaa; Hesselø; Isefjord; Lynæs, harbour. — **Sa**: Coast below Ris Skov; Aarhus, harbour; Odense Fjord: inner side of Enebærødden; Hofmangave (Lyngbye, Hofm. Bang, C. Rosenb.). — **Lb**: Bogense; Fredericia; Middelfart; Kongebro; Snoghøj; Fænø Sound; Assens; Faaborg; Dyreborg. — **Sf**: CT west of Taasinge; Svendborg; Marstal, specimens up to 70 cm long, among *Zostera* in shallow water, frequently on *Littorina*; Skaarupør; Lohals. — **Sb**: South side of Refsnæs; Kerteminde; Korsør; Nyborg, harbour and Avernakhage; Vresen; Spodshjerg, harbour; DQ, 5,5 meters; UR, 7,5 meters. — **Sm**: VC, Venegrund 4—4,5 meters. — **Su**: Hellebæk; Helsingør (Liebman, C. Rosenb., !); Humlebæk; Sletten; TF¹, Staffans Flak, 12—13 meters. OG¹, between Trekroner and Middelgrund, c. 9,5 m; Trekroner (Liebman, Ørsted a. o.); RH, Knollen, 9,5 m; Dragør; PR, off Dragør, 7,5—9,5 m. — **Bw**: KU, Schönheyders-Pulle, 6,5 m.

Dilsea Stackhouse.

1. *Dilsea edulis* Stackhouse.

Stackhouse, Mém. soc. Mosc. II, p. 55, 71 (non vidi).

Fucus edulis Stackhouse, Ner. Brit. 1. ed. p. 57 (non vidi), II. edit. 1816 p. 22, tab. 12 (good).

Halymenia edulis (Stackh.) Agardh; Flora Danica tab. 2258, 1839.

Iridaea edulis (Stackh.) Bory; Harvey, Phyc. Brit. pl. 97; Areschoug Phyc. scand. p. 89; Kützing, Tab. phyc. 17. Band, tab. 3a.

Schizymenia edulis (Stackh.) J. Agardh, Sp. g. o. II, 1851, p. 172.

Sarcophyllis edulis (Stackh.) J. Agardh, Sp. g. o. III, 1876, p. 265.

From a basal disc a number of flat fronds arise. Their number may be considerable, but when they are numerous they are for the greatest part feebly developed. They attain not seldom a length of about 30 cm; the largest specimen I have measured was 61 cm long in a dried state. As to the anatomy of the frond, reference may be made to the papers of WILLE (Bidrag til Algerne's physiologiske Anatomi. K. sv. Vet. Ak. Handl. Bd. 21, 1885, p. 71. tafl. V fig. 61—67, and Beiträge zur Entwickl. d. physiolog. Gewebesyst. Nov. Act. Leop. Car. Ak. Bd. LII Nr. 2, 1887, p. 83, Taf. 5 fig. 72—74 and Taf. 6 fig. 75).

In summer the species is always sterile. It is evidently fructiferous in winter, just as on the British coasts. Tetraspores were found in specimens collected in February to April; they were confined to round or oblong patches measuring at the most 1 cm in diameter. In a specimen collected in May the spots were still visible, but the sporangia were emptied. The sporangia are more or less deeply immersed in the cortex. They arise directly from cells of the inner cortex, and are thus intercalary, being outwardly connected through pits with filaments of the cortex (fig. 76). The ripe sporangium is surrounded by a double sporangial wall. The spores are paired, decussately or cruciately, the dividing walls are often inclined. The spores contain a number of small chromatophores.

The cystocarps are situated in the inner cortex, or at the limit between it and

the medulla. The carpogonial branch is five-celled, the auxiliary-cell branches are curved, and composed of a great number of short cells (fig. 77). Ripe cystocarps have been met with in March. — Antheridia have not been met with.

The species is distributed in the Skagerak, in the northern and eastern Kattegat and in the northern part of the Sound. In the Skagerak it does not attain the same dimensions as in the Kattegat, its length scarcely exceeding 30 cm, probably owing to the more agitated water. It has here only been met with at comparatively slight depths, viz. 4 to 9,4 m. In the Kattegat it is mainly distributed in the eastern part, where it has been met with almost only at depths of 16 m or

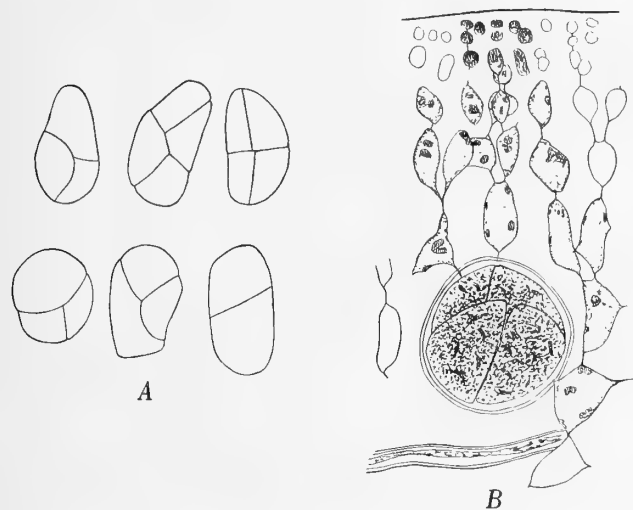


Fig. 76.

Dilsea edulis. A, six sporangia showing various forms and modes of division. 220:1. B, transverse section of cortex with a sporangium. 390:1.

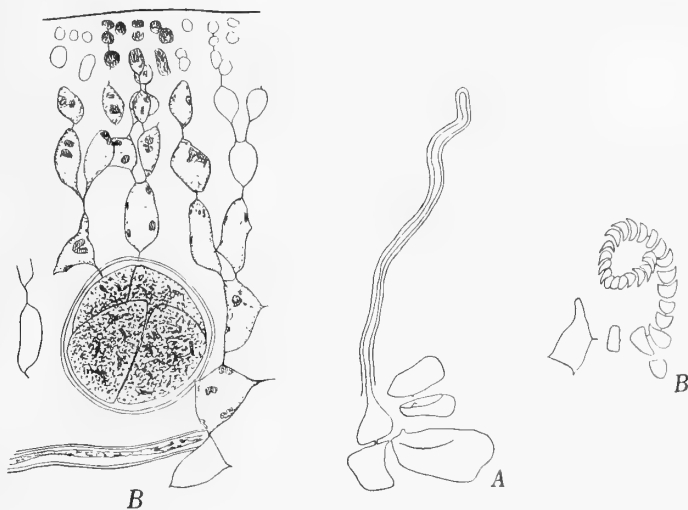


Fig. 77.

Dilsea edulis. A, carpogonial branch. B, auxiliary-cell branch. 390:1.

deeper, where the salinity is high and little variable and the variations of temperature are also relatively small; it attains here its greatest size. — In most localities it is taken only in small quantities in the dredge; I have found it most abundantly at Hanstholm (Sk), where it was dominant in some places at 7,5 meters depth. LYNGBYE found it off Gilleleje on the North coast of Sealand, 12 miles from land at 26 meters depth, abundantly in places where other algæ are not met with, but only *Mytili* and other molluscs, barnacles etc. It was here often fixed to the mytili and attained a size of up to 63 cm; the fishermen called it here “røde Klude” (red rags).

Localities. Sk: YT off Hanstholm lighthouse, 7,5 met., rather abundantly; Thorup Strand, washed ashore (C. M. Poulsen); Løkken, washed ashore, FK Kongshøj Grund off Lønstrup, 8,5 met.; NW of Hirshals, 30 met., some fragments (A. C. Johansen); west side of Hirshals mole, 4 met., washed ashore by Lønstrup and Hirshals, Tværsted (V. Schmidt) and Skagen. — Kn: Herthas Flak, 20—22 met., 6 cm long; Hirsholmene, 5,5—7,5 m, 6 cm long; North of Læsø (Edv. Bay), 29 cm long; IX, 11 m; TR near Trindelen, 23,5 m. — Ke: Fladen, ZF, 22,5 m, and IQ, 22—30 m; south side of Groves Flak (Børgesen);

IK Lille Middelgrund, 17—19 m, 61 cm; IH, south side of Lille Middelgrund, 20—28 m; ER, Fyrbanken east of Anholt, 23 m, 28 cm; IA, Store Middelgrund, 16,5 m; same locality (Børgesen); off Gilleleje, 12 miles from land (Lyngbye); Nakkehoved (Lyngbye). — **Su**: Washed ashore at Hellebæk (Rasch, Børgesen), 29 cm, and north of Helsingør (Steenberg, C. Rosenberg, ¹) 26 cm, bM, south of Hveen, 22,5 m, loose, 40 cm.

Fam. 5. Nemastomataceæ.

Platoma (Schousboe) Schmitz.

1. *Platoma Bairdii* (Farlow) Kuckuck.

P. KUCKUCK, Beiträge zur Kenntn. d. Meeresalgen. 12. Ueber *Platoma Bairdii* (Farl.) Kck. — Wissensch. Meeresuntersuch. Neue Folge. V. Bd. Abt. Helgoland, Heft 3. 1912, p. 187—203. Taf. IX—XI.

Nemastoma (?) *Bairdii* Farlow, Proceed. Amer. Acad. Arts and Sciences, 1875, p. 351; Mar. Algæ of New England, 1881, p. 142; BATTERS, Cat. Brit. Mar. Alg., 1902, p. 94.

Helminthocladia Hudsoni Batters, Journ. of Bot. 1900, p. 377, Tab. 414 fig. 15—16, non J. Agardh.

In July 1915 I found by dredging in Lille Belt some small specimens of this interesting Alga, hitherto only recorded from three widely remote places (coast of Massachusetts, coast of Northumberland and Helgoland). As the structure and development of the species have recently been exhaustively treated by Prof. KUCKUCK, I shall only make some few remarks upon the Danish specimens, referring for the rest to KUCKUCK's excellent description.

The plant forms small bundles on a granitic pebble, each given off from a well developed basal disc, and reaching only a length of 1 cm. The upright fronds are more or less branched, rarely unbranched, terete, or the thickest fronds somewhat flattened. As shown by KUCKUCK, the frond branches by dichotomy¹, but one of the shoots produced by the division often becomes more vigorous than the other, and the ramification then seems to be lateral. Hyaline hairs were not met with; according to KUCKUCK their occurrence is variable.

The plants bore either tetrasporangia or carpogonia and cystocarps, while antheridia were not met with either here or at Helgoland. The two kinds of individuals were quite distinct; no carpogonia were observed in the tetrasporiferous specimens or vice versa (comp. KUCKUCK l. c. p. 192). The emptied sporangia were frequently replaced by a sporangium produced from the subjacent cell. "Prospory" ♂: production of sporangia from the basal disc, was not met with in the Danish specimens.

Locality. **Lb**: At Lyngs Odde, right opposite Middelfart, stony bottom, about 20 meters depth.

¹ KUCKUCK thinks (l. c. p. 190) that the dichotomy in this plant is only apparent, as it cannot be derived from a longitudinal division of the apical cell. This, however, must be considered a too narrow definition of the conception of dichotomy. In my opinion, dichotomy exists in all cases where the growing point divides into two equal parts by a vertical dividing plane or furrow, the two parts at first diverging equally from the original direction of growth, no matter whether the growing point consists of a single cell (*Dictyota*) or of several cells (*Furcellaria*, *Lycopodium*, *Selaginella*, roots of *Isoetes* etc.) or is a part of a coenocytic organism (*Thamnidium*, *Piptocephalis*).

Halarachnion Kützing.

1. *Halarachnion ligulatum* (Woodw.) Kützing.

Kützing, Phycol. gener. p. 394, Taf. 74. I; Berthold, Cryptonem. d. Golfes von Neapel, Leipzig, (1884) p. 22 (an eadem species?); T. H. Buffham, On the Antheridia etc. of some Floridæ. Journ. of the Quekett microscop. Club, Vol. V, ser. II p. 299, tab. 14 fig. 37—39.

Ulva ligulata Woodward, Linn. Trans. III p. 54.

Halymenia ligulata (Woodw.) Agardh, Spec. Alg., 1821, p. 210; Flora Danica tab. 2199 (1836) from Helgoland; Harvey, Phyc. Brit. vol. I pl. 112, 1846; J. Agardh, Spec. g. o. Alg. II, 1851 p. 201; Bornet et Thuret, Notes algologiques, fasc. 1, Paris 1876, p. 44 pl. XIV, XV.

I have only found a few small specimens of this species and have not submitted them to closer examination. As to the structure of the frond, reference may be made to the descriptive works and the quoted figures of HARVEY, KÜTZING, BORNET and THURET, which show that the inner part of the compressed frond consists of a slimy substance through which run widely spread medullary filaments, while the cortex is composed of two or three layers of cells. Colourless, rather thin hairs proceeding from peripheral cells were observed in specimens from Herthals, but none in the other examined specimens. BERTHOLD (l. c. p. 7) did not observe them.

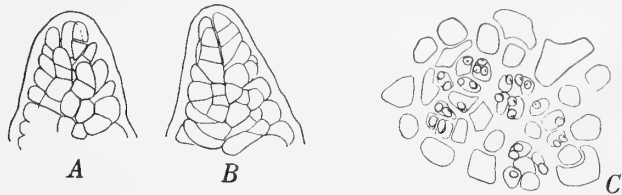


Fig. 78.

Halarachnion ligulatum, from X.J. A and B, tips of slender shoots showing two filaments reaching the top. — C, surface of male plant. 630:1.

In a small specimen from Herthas Flak I found in slender shoots two filaments running to the very end of the shoot, with the two apical cells at the same level and higher than those of the other filaments (fig. 78 B). In thicker shoots such structure is not to be found; the end of the shoot seems to be composed of a greater number of equal filaments.

Sporangia have never been found in this species.

The antheridia occur in the same specimens as the carpogonia (comp. BORNET et THURET, l. c. p. 45; BERTHOLD, l. c. p. 9). They have been briefly described and figured by BUFFHAM (l. c.). According to this author they arise from "a cell which produces four male cells above, and these emit the pollinoids, which are minute." I found their arrangement less regular, their number, seen from the face, varying from 1 to 4 (fig. 78 C). As I had not occasion to examine them in transverse sections, I am not able to decide whether the small cells shown in the figure are really the antheridia (spermatangia) or possibly partly antheridia-producing cells (spermatangial mother cells after SVEDELIUS), as BUFFHAM's fig. 39 may suggest.

The carpogonial branches are 4-celled, situated on the inner side of the cortex, and bent outwards (BORNET and THURET l. c. fig. 1). According to BERTHOLD and SCHMITZ, the fertilized carpogonium gives off in various directions a number of

sporogenous filaments which fuse with the auxiliary cells occurring in great numbers on the inner side of the cortex. After the fusion the auxiliary cell produces on its inner side the gonimoblast (BORNET and THURET l. c. fig. 2—5). The ripe cystocarp is globular or somewhat lobed; it projects in the slimy medullary space (KÜTZING l. c., BORNET and THURET fig. 2—4).

The species has only been found in three localities in the northern Danish waters. The largest specimen (from TQ) is 4,5 cm long, 3 mm large. It has been found with antheridia and carpogonia in July, with cystocarps in August and September. It occurs on stony or gravelly bottom. — At Helgoland it has been found in well developed specimens, and it has been met with at Väderöarne, Bohulän.

Localities. **Sk**: 1 mile NW of Hirshals, 15 m. — **Kn**: XI, Herthas Flak, 20—22,5 m; TQ, at Trindelen light-ship.

Furcellaria Lamouroux.

1. *Furcellaria fastigiata* (Hudson) Lamouroux.

LAMOUROUX, Ann. du Mus. XX. 1813, p. 46; GREVILLE, Alg. Brit. 1830, p. 67, tab. XI; KÜTZING, Phyc. gener. 1843, p. 402, Taf. 71 (habit and anatomy); HARVEY, Phyc. Brit. I, 1846, pl. 94, III, 1851, pl. 357 (cystocarps and tetraspores); ARESCHOUG, Phyc. Scand. mar. 1850, p. 88, Tab. IV A; CASPARY, Observations on *Furcellaria fastigiata*, Huds. and *Polyides rotundus* Gmel. Ann. & Mag. N. Hist. Ser. 2, Vol. VI, 1850; J. AGARDH, Spec. I, 1851, p. 196; THURET, Rech. s. l. fécondation des Fucacées et des anthéridies des Algues. II. Ann. d. sc. nat. 4e sér. tome 3, 1855, p. 42 pl. 3 fig. 6—7; KÜTZING, Tab. phyc. Bd. 17, tab. 99, 1867.

REINKE, Allgem. Botanik, 1880, p. 134 fig. 97 (longitudinal section of extremity of frond), Algenflora w. Ostsee, 1889, p. 26 (f. aegagropila); WILLE, Alg. physiolog. Anatomi, 1885, p. 55, 63, 84 ex parte, not Tafl. VIII fig. 14, Beitr. physiol. Gewebesyst., 1887, p. 86, Taf. 6 (VIII) fig. 76—78; KOLKOWITZ, Beitr. z. Biol. der Florideen. Wiss. Meeresunters. N. Folge. 4. Bd. Abt. Helgoland Heft 1. 1900, p. 31, 46, fig. 4; SVEDELIUS, Stud. Östersj. hafsalgfl., 1901, p. 130; OLTMANNS, Morph. u. Biol. d. Alg. I, 1904, p. 545, fig. 329 (longitudinal section of upper end of frond and transverse section of frond); DENYS, Untersuch. an *Polyides rotundus* Gmel. und *Furcellaria fastigiata* Lamour., Beih. z. Jahrb. d. Hamburg. wissenschaftl. Anstalten. 1910.

Fucus fastigiatus Hudson Fl. angl. ed. 1. 1762, p. 588; Oeder, Flora Danica tab. 393, 1768 (with adventitious shoots).

Fucus furcellatus Oeder Fl. Dan. tab. 419, 1768.

Fucus lumbricalis Gmel., Hornemann, Flora Dan. tab. 1544, fig. 6, 1816 (tetrasporangia).

Furcellaria lumbricalis Lyngbye, Tent. Hydr. p. 40, tab. 40 A, 1—4.

Fastigiaria furcellata (L.) Stackhouse, Le Jolis, Liste Alg. Cherbourg, 1864, p. 124.

The mode of growth, ramification and structure of this common alga has so often been described and figured that it may be sufficient to refer to other works, adding only some supplementing remarks.

The apex of the frond consists of a great number of densely joined cell-filaments which are parallel and vertical in the middle, becoming gradually more divergent towards the periphery. ("Springbrunnentypus" of OLTMANNS). The central filaments continue downwards in long longitudinal filaments, which constitute an essential part of the medulla, while the more peripheral ones gradually develop into the cortex, which consists of radiating, dichotomously branched filaments. The

outer small cells form an assimilatory tissue; the cells of the inner cortex are much larger, containing also several bandlike and ramified chromatophores, but the total mass of these bodies is small compared with the volume of the cell. WILLE mentions these cells as store-cells, "Speicherzellen" (1887 p. 87), as floridean starch is stored in great quantity in them. These cells are connected with each other by small pits.

The cell-rows of the cortex depart from the longitudinal filaments of the central tissue, which consists not only of these filaments but also of irregular hyphæ originating as outgrowths from the barrel-shaped cells of the inner cortex (fig. 79). The difference between these two kinds of filaments in the medulla has already been remarked by older authors as KÜTZING and CASPARY; WILLE on the other hand (1885 and 1887) only refers to the secondary hyphæ but not to the primary longitudinal filaments¹. The difference is conspicuous, the longitudinal filaments running very regularly and consisting of long cylindrical cells connected with large pits, while the hyphæ run irregularly, though chiefly in a transversal direction, and are composed of more heterogenous cells, those of the proximal part being more or less inflated, while the cells of the distal part are cylindrical. The cells of the hyphæ contain narrow, partly branched chromatophores. In the longitudinal filaments I did not observe any chromatophores, but DENYS (l. c. p. 10) states that their cells contain colourless ones. This author states that the hyphæ are given off from the longitudinal filaments²; it is possible that they may also be produced by these,

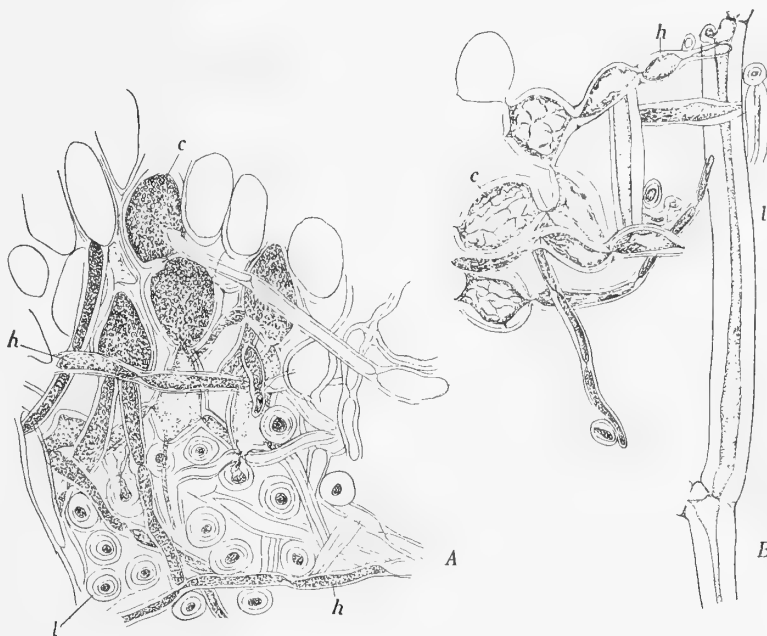


Fig. 79.

Furcellaria fastigiata. A, transverse section of frond, at the limit between the medulla and the inner cortex. B, longitudinal section of the same. c, inner cortical cells; l, longitudinal filaments; h, hyphæ. After living material, April. (190:1).

¹ For illustration of the anatomical structure of this species WILLE gives only a copy of a figure by KÜTZING (Phycol. gener. tab. 72 fig. 6; WILLE Taf. VIII fig. 14), representing *Furcellaria lumbialis*; but this is identical with *Polyides rotundus*, which differs from *Furcellaria* just in the structure of the medulla. OLTMANNs makes the same error (1904 p. 546 fig. 330).

² DENYS calls the longitudinal filaments "Längshyphen," but incorrectly, as these filaments have not the active apical growth combined with slipping growth ("gleitendes Wachstum") characteristic of the hyphæ.

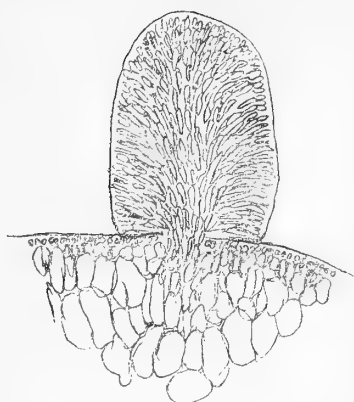


Fig. 80.
Furcellaria fastigiata. Adventitious
shoot in longitudinal section. 95:1.

though I have not observed it, but when DENYS says that they "schliessen nach kürzerem oder längerem Verlauf an die inneren Zellen der mittleren Rinde" (l. c. p. 10) he must have misinterpreted the facts observed. WILLE's statement (1887, p. 87) that these cells "mit einander sowohl als auch mit den Speicherungszellen durch Poren in Verbindung treten" might be understood as if the pits were secondary, whereas in reality they are primary. Whether secondary pits may be formed between the hyphæ, or between these and other cells, I have not observed. — In late summer, autumn and winter these cells are rich in starch. As to the starch compare for the rest KOLKWITZ (l. c.). All the vegetative cells contain a single nucleus. Hairs are never produced.

As to the stolons reference may be made to the descriptive works and to KOLKWITZ (l. c. p. 46) and DENYS (l. c. p. 8).

The erect fronds are, as is well known, branched by dichotomy, but besides this normal ramification adventitious branches sometimes occur, especially in the inner Danish waters (Sa, Sf, Sb, Su, Bw) (Flor. Dan. tab. 393). They originate from a little group of superficial cells. In developing they increase early in thickness so that their basal plane is much larger than their plane of insertion (fig. 80). They may be very numerous, as for instance in some specimens dredged in January in Store Belt (NU, no. 4250) at 11 meters depth, the shoots of which were, for a length of one to three cm or longer, more or less densely beset with very short adventitious shoots; some older shoots of this kind had again produced adventitious buds. The cause determining the appearance of these shoots is unknown; the plants producing them may be fertile. Another sort of adventitious shoots develop from the scars arising from the decaying and falling off of the fructifying parts of the shoots (fig. 81, comp. HARVEY, Phyc. Brit. Plate 94). As shown



Fig. 81.
Furcellaria fastigiata.
Adventitious shoots grow-
ing out from scars. Hirs-
hals June. 1,5:1.

by CASPARY (l. c. p. 93, fig. 10) this regeneration can be once or twice repeated.

The reproductive organs are produced in the upper part of the fronds; their development begins at the end of the summer or in the beginning of the autumn. In August very young sporangia may be found



Fig. 82.
Furcellaria fastigiata. A, young sporangia
in transverse section of frond, August. 220:1.
B, ripe sporangium. 230:1.

in the inflated ends of the frond. They appear as small cells cut off from the outer end of the large cells of the inner cortex, and differ from these by the want of starch, by the higher staining power in presence of hæmatoxyline, and in containing a large, intensely staining nucleus (fig. 82 *A*). The sporangia increase in September and October; in November specimens with undivided and divided sporangia may be met with. In December the sporangia are always ripe; at the end of

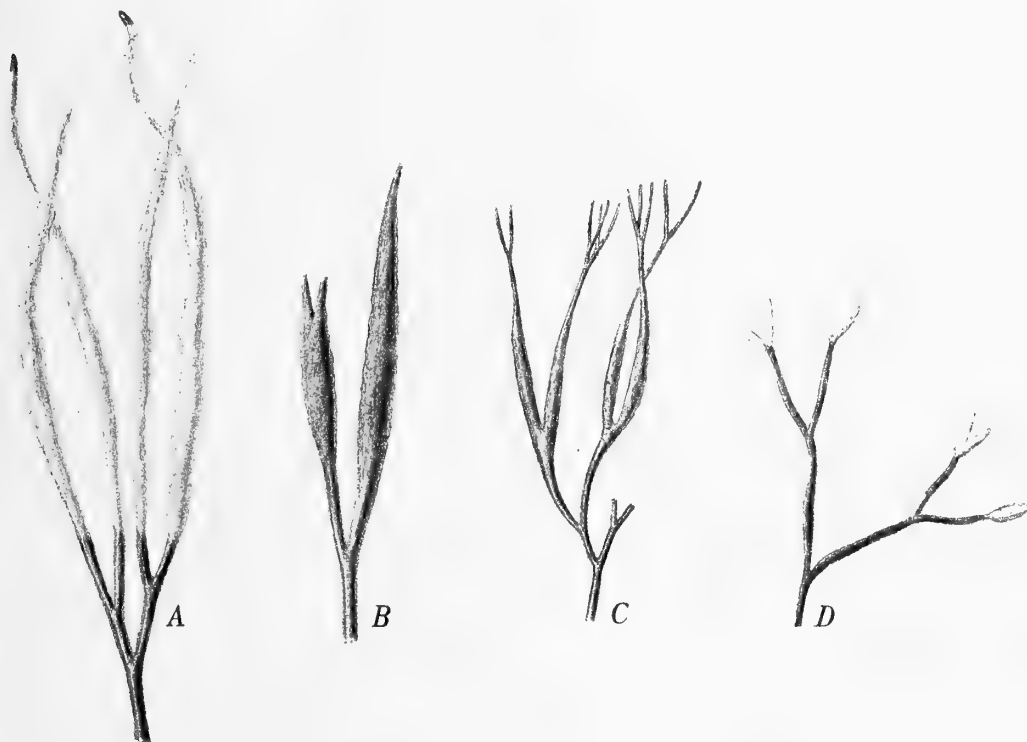


Fig. 83.

Furcellaria fastigiata. *A*, part of frond with emptied tetrasporangia, December. *B* and *C*, parts of fronds with ripe cystocarps, December. *D*, part of frond with antheridia, March. Nat. size.

December and in January they are often emptied, but in February many sporangia containing spores are still to be found. As is well known, the sporangia are oblong and "zonate" σ : divided by parallel walls; the spores contain numerous small chromatophores (fig. 82 *B*). The parts of the frond producing tetrasporangia are somewhat inflated, fusiform; after the exhaustion of the spores they are a little more inflated, soft and green, while the other parts of the frond in winter are dark red-brown. The upper tip of the frond sometimes remains sterile and therefore retains its dark colour. Downwards the fertile part is sharply marked off from the sterile frond and loosens here in decaying during the winter (fig. 83 *A*).

The antheridia cover the surface of small terminal inflated segments of the frond; which are about 1 cm long, of a pale rose colour (fig. 83 *D*). They are given off

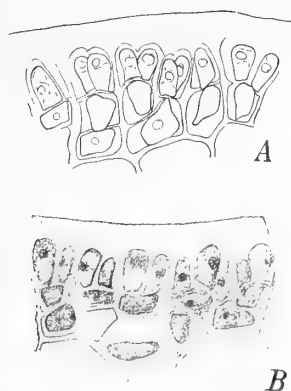


Fig. 84.

Furcellaria fastigiata. Transverse sections of antheridia-bearing fronds, Decemb. 835:1.

from small cells, not infrequently smaller than themselves. In a transverse section of the frond these androphore-cells, which seem to contain chromatophores, are seen bearing two antheridial cells of different age. Probably they may sometimes bear more than two, and the production of antheridia may possibly be continued after the first has been exhausted. The antheridia always occur in particular male plants; they were first described and figured by THURET in 1855. Fully developed antheridia have been met with in December, but they may probably occur much earlier. Antheridia containing ripe spermatia have further been found in January to March, and in May I have still found specimens with white antheridial branches containing numerous spermatia (no. 5793, UL, Øjet, in Bw, 20 meters depth).

The carpogonia appear at the end of the summer, and in August young goni-

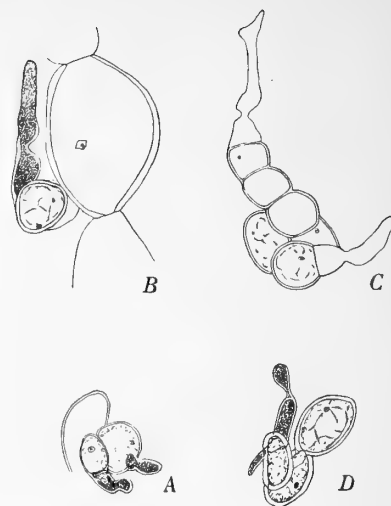


Fig. 85.

Furcellaria fastigiata. Carpogonial branches. A and B, two-celled, C and D, 3- and 4-celled. In D, the carpogonium has produced an outgrowth (sporogenous filament?) at the base, although the trichogyne is very short and unfertilized. A, September, 230:1, B—D, August, 390:1.

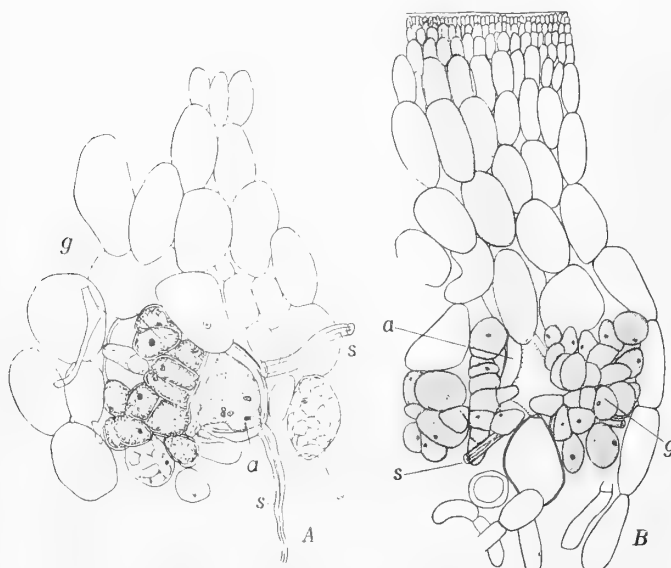


Fig. 86.

Furcellaria fastigiata, sections of fronds with young cystocarps, August. a, auxiliary cell; s, sporogenous filaments, g, gonimoblast. 210:1.

moblasts may already be met with. The carpogonial branches arise in the inner cortex or at the limit between the cortex and the central tissue; they are frequently placed in small groups, and two or three of them may be given off from one of the large storage cells. They are almost always two- or three-celled. The inferior cells of the carpogonial branches are globular or ovate, they contain one or two nuclei, small chromatophores and numerous small starch grains. The carpogonium is much narrowed over the basal part, the narrowing being deepest on one

side (fig. 85 *B*). I cannot give any details about the contents of the carpogonium, as on staining with hæmatoxyline it was in a great part very dark and intransparent. In the specimens collected in August and September numerous carpogonia with short trichogynes were found; other carpogonia had long trichogynes making their way outwards through the cortex, and tips of trichogynes protruding through the surface of the frond were also met with, but I have not yet seen spermatia fixed to them, and it remains thus to state whether fertilization takes place normally or the cystocarp may develop parthenogenetically, as in *Platoma Bairdii*. The car-

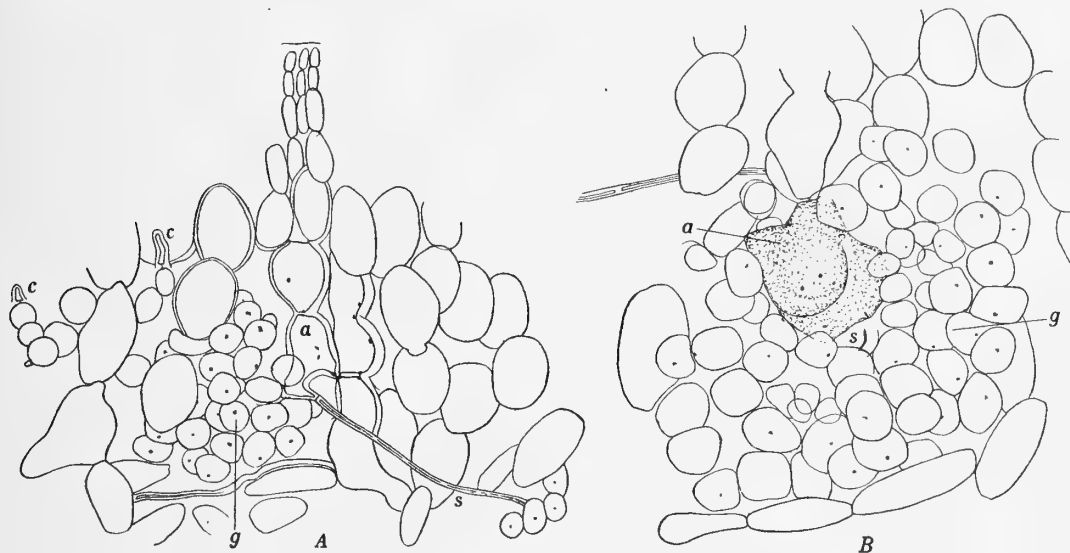


Fig. 87.

Furcellaria fastigiata. Sections of frond with young cystocarps. *c*, carpogonia; *a*, auxiliary cells; *g*, gonimoblasts. September. A 180:1. B 190:1.

pogonium shown in fig. 85 *D* seems to agree with the latter assumption, as an outgrowth is given off from the base of the carpogonium, while the trichogyne is very short and unfertilized.

The auxiliary cells (*a* in the figs.) arise, as stated by SCHMITZ (Engler u. Prantl, p. 526), from single cells in the inner cortex which seem to be at first but little different from the vegetative cells. They fuse with the long sporogenous filaments produced by the carpogonia and growing widely between the inner cortical cells and the medullary filaments. The fusion takes place at the inner end of the cell. After the fusion the auxiliary cell soon begins to produce gonimoblast cells laterally and at the inner side, and thus young cystocarps may occur already in August (fig. 86). The auxiliary cell after fertilization contains a number of nuclei, four or more, some of which certainly derive from the original nucleus of the cell, while the others are sporogenous (fig. 86 *A*, 87). The cell increases in volume and takes a more irregular outline. Fusions between neighbouring cortical cells seem to occur (fig. 87).

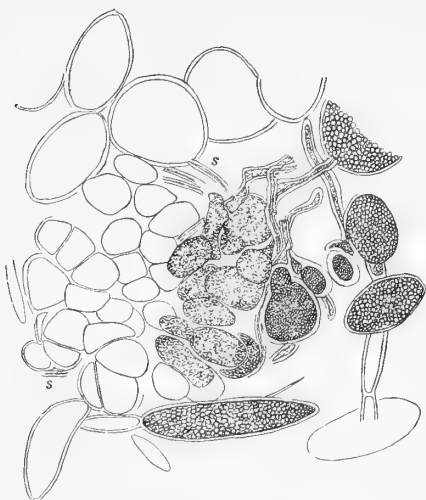


Fig. 88.

Furcellaria fastigiata. Section of young cystocarp. At right several carpogonia. *s*, sporogenous filaments. The cells of the young cystocarp contain minute starch grains while those of the surrounding cells are much larger. August. (200:1).

destruction of the cells of the darker stripe mentioned above. The fructiferous part of the female fronds is more or less inflated, almost as in the sporangia-bearing ones, but the upper part of the fronds frequently remains sterile; this part may be 1 to 2 cm long and branched (fig. 83 C).

Germinating spores of what must be supposed to be *Furcellaria fastigiata* are frequently met with on various Algæ, as *Delesseria*, *Phyllophora* a. o. They are at first hemispherical, and are divided by rather regular anticlinal and periclinal walls

without changing form, but increasing in size (fig. 89 A). Later on, a cylindric upright shoot of the typical structure is produced from this hemispherical body, the shoot being a little narrower as the basal part (fig. 89 B). These shoots later branch and produce rhizomes at their base.

This Alga is one of the commonest and most widely distributed in the Danish waters. It attains its highest degree of development in the Kattegat and the Belts, where it becomes up to 28 cm high. In the western Baltic it attains a length of 24,5 cm, whereas at Bornholm I have

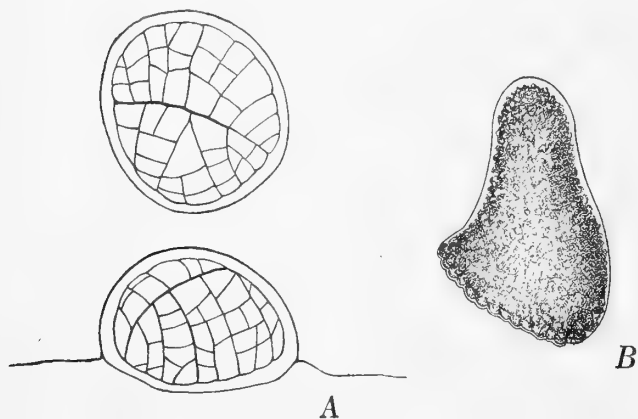


Fig. 89.

Furcellaria fastigiata. A, germinating spores, seen from above and from the side. B, older stage showing a cylindric shoot growing out from the hemispherical body.

not found it higher than 9 cm. In the inner Baltic Sea SVEDELIUS found it scarcely more than 10 cm high. He refers the plants here found to *f. minor* Agardh, a form differing only by smaller dimensions, in citing Fl. Dan. tab. 393 and ARESCHOUG, Alg. Scand. exs. No. 257. In the most feebly developed specimens the erect shoots are not branched, or but little so (fig. 90). — *Furcellaria* grows usually on stones or pebbles, but may also be found fixed on other Algæ, as *Phyllophora*, *Chondrus*. In some places north of Fyn (especially aZ, near Fyns Hoved) it was found growing in company with other, mostly loose, Algæ forming a dense cover over the bottom, which consisted of coarse sand. I am not certain whether these specimens were at first loose or originally fixed at this stationary bottom. In other places detached specimens lying loose on the bottom are met with, often in great quantities, particularly in fjords, as Limfjorden, but also in the Kattegat, e. g. around Anholt. It is apparently able to live long in this condition, for plants in which the under part is in a state of disorganization are often met with. Some of these plants are not much different from the normal ones; in other cases they are more branched, and form globular bushes corresponding to those mentioned by REINKE (1889) and SVEDELIUS as *f. ægagropila* (fig. 91).

The species has been found in depths from 2 to 28 meters and once in 38 m depth (near Bornholm). It is often a predominant element of the vegetation, particularly in depths of 4 to 15 m. It is perennial, but the fructifying shoots are shed in winter. In sunny localities the upper parts of the fronds are green in summer.

Localities. Ns:
Only found at ZQ, jyd-
ske Rev, 24,5 m and at

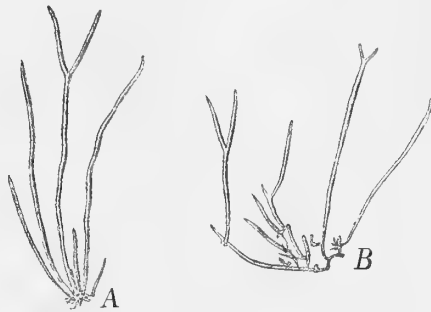


Fig. 90.
Furcellaria fastigiata. Plants from the Baltic
Sea off Gudhjem, Bornholm. Nat. size.

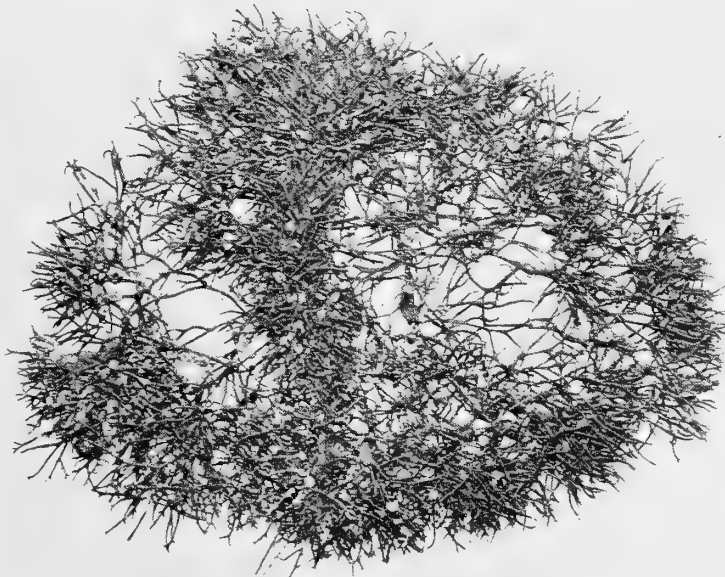


Fig. 91.
Furcellaria fastigiata ægagropila. From Guldborgsund. Nat. size.

Ørhage by Klitmøller inside the point at 2 meters depth, farther from land off Klitmøller only a few small specimens. — **Sk**: Collected at various places (Hansthølm; Bragerne; washed ashore by Svinkløv and Blokhus; Lønstrup; Hirshals; Skagen) in 2 to 13 m depth, in most of the places only in small and scarce specimens. Found in greatest number and best developed at Hirshals, near land in 5 m depth, in company with *Polyides*. Greatest length observed 15 cm. — **Lf**: Widely distributed, down to a depth of 6,5 m, but in most places loose, often in abundance on soft bottom (f. *ægagropila*). Reaches a length of 8–14 cm. — **Kattegat**: Common and often abundant everywhere on stony bottom in depths down to 15 cm. It reaches here a length of up to 28 cm and is very often over 20 cm high. It has also been dredged in several places in greater depths, down to 30 m (e. g. ZB, Trindelen, about 30 m; ZS, Fladen, 26,5 m; HZ, Store Middelgrund, 25,5 m), but it is more frequently missing than present in these greater depths, and, at all events, it occurs only in small quantities. In Herthas Flak in **Kn**, where I have dredged several times in 20 to 24,5 meters depth, it has never been met with. In Isefjord it has been recorded in various places, in Holbæk Fjord it occurs abundantly in a loose condition. — **Sa** and **Lb**: Common in depths down to 24 m; at aZ growing gregariously over coarse sand (see above). — **Sf**: Several places. — **Sb**: Common in depths down to 20 m, greatest length observed 27 cm; generally well developed specimens. — **Sm**: Several places down to 12 m depth; greatest length observed 10,5 cm — **Su**: North of Helsingør up to 25 cm high, south of Helsingør in depths down to 13 m, up to 16 cm high. — **Bw**: Found in depths down to 20 m; greatest length observed 24,5 cm. — **Bm**: Greatest length observed 12 cm. — **Bb**: Found in depths from one to 38 m (YA, east of Bornholm) in several places, but reaching only 9 cm in length.

Fam. 6. Rhizophyllidaceæ.

Polyides Agardh.

1. *Polyides rotundus* (Gmel.) Grev.

Greville, *Algæ Britann.*, 1830, p. 70, Tab. XI. Harvey, *Phycol. Brit.* pl. 95, 1840. Caspary, *Ann. and Mag. N. Hist. Ser. 2*, Vol. VI, 1850, p. 93. Thuret in *Le Jolis Liste des Alg. mar. de Cherbourg*, 1864, p. 140. Thuret et Bornet, *Etudes phycologiques*, 1878, p. 73–80, pl. 37–39. Guignard, *Développ. et const. des anthérozoïdes. Revue gén. de Botanique*. I, 1889, extrait p. 44, pl. 6 fig. 10–12. Fr. Schmitz, *Kleinere Beitr. z. Kenntn. d. Florideen*. II. *La Nuova Notarisia*. Ser. IV. 1893, Estratto p. 8. Kolkwitz, *Beitr. z. Kenntn. d. Florideen. Wiss. Meeresunters.* N. F. 4. Bd. Abt. Helgoland. Heft 1, 1900. Denys, *Anatom. Untersuch. an Polyides rotundus Gmel. und Furcellaria fastigiata Lamour.* Beih. z. Jahrb. d. Hamburg. wissenschaft. Anstalten 1910.

Fucus rotundus Gmelin, *Hist. Fucor.*, 1768, p. 110 tab. VI fig. 3. *Flora Danica* tab. 1544 a (Hornemann 1816). *Furcellaria rotunda* Lynghye, *Tent. Hydr.*, 1819, p. 49.

Polyides lumbricalis C. Agardh, *Spec. Alg.*, 1822, p. 392, J. Agardh, *Sp. g. o. II*, 1863, p. 721.

Furcellaria lumbricalis Kützinger, *Phycol. gener.*, 1843, p. 402, Taf. 72, Tab. phycol., Bd. 17, 1867, pl. 100.

The external resemblance between this Alga and *Furcellaria* is well known and has often been mentioned, as well as the difference of the basal part being a disc in *Polyides*, while in *Furcellaria* it consists of branched rhizomes. The structure of the erect frond has already been thoroughly studied by KÜTZING (1843)¹ and CASPARY (1850). The structure of the upper end of the frond is that of the fountain type (Oltmanns' "Springbrunnentypus") as plainly shown by KÜTZING (l. c.). As to the structure of the erect fronds, reference may be made to the papers of

¹ The troublesome synonymy of this Alga is responsible for the fact that WILLE (*Bidr. t. Alg. phys. Anat. K. Svenska Vetensk. Ak. Handl.* Bd. 21. 1885, tafl. VIII fig. 14) and OLTMANNS (1904, p. 546, fig. 330) have used copies of KÜTZING's figures of it to demonstrate the anatomy of *Furcellaria fastigiata* (comp. p. 165).

KÜTZING, CASPARY, THURET (1878, p. 75, pl. 37, fig. 6) and DENYS. The outer cortex consists of a greater number of layers of small cells (up to 4 or 5) than in *Furcellaria*. The longitudinal filaments of the central tissue are mostly thicker at the ends than in the middle "so that they have the form of a femur" (CASPARY, p. 94). The cells which form the connection between these filaments and the cortical ones are arranged in regular feebly curved rows running obliquely upwards, while secondary hyphæ are wanting¹. Hyaline hairs produced by superficial cortical cells may occur, according to THURET (1878, p. 75, pl. 37, fig. 6). I have not observed these hairs, but in specimens collected in April I found that some of the peripheral cells were colourless, narrower and longer than the others; probably they were about to develop into such hairs. As to the cell-structure, reference may be made to the paper of DENYS. The pit in the transverse wall between the cortical cells is very narrow, while that of the longitudinal filaments is broad, and provided with a double plate. Secondary pits do not occur. The structure of the basal disc has been figured by KÜTZING (1843); according to KOLKWITZ (1900, p. 51) older discs are stratified.

The tetrasporangia arise at about the limit between the outer and inner cortex (comp. CASPARY, 1850, fig. 21, THURET, 1878, pl. 36, fig. 6 and 7). As shown by THURET, an issue is formed outwards to each sporangium by removal of the cells from each other, through which issue the contents of the sporangium is emptied. Specimens with undivided sporangia have been met with in October, with ripe sporangia in January and with emptied sporangia in April.

The antheridia arise, as shown by THURET, in nemathecium in particular individuals. According to GUIGNARD (1889, p. 44, pl. 6, fig. 10—12) they are placed in tetrads directly on the nemathecium filaments, while SCHMITZ asserts (1893, p. 8) that they are situated on short cells given off from the filaments. I cannot give any information on this point, as I have not met with male plants in the Danish waters.

As to the structure and development of the female nemathecium, reference may be made to the classical researches of THURET and BORNET (1878, p. 77—80, pl. 38—39). These bodies begin to develop in the Danish waters in August or September. In specimens dredged at the entrance to Vejle Fjord, August 20th, nemathecium with well developed but unfertilized carpogonia were found. Similar carpogonia but also others with fertilized carpogonia are frequently met with in September. Ripe cystocarpia were found in December and January. After the exhaustion of the carpospores, the nemathecium are thrown off, while the fronds which have produced them possibly may continue growing. — The germination of the carpospores has been observed by THURET et BORNET (1878, p. 79, pl. 39, fig. 32); they obtained hemispherical bodies producing rhizoids from their under face.

¹ DENYS speaks (l. c. p. 7) of "Querhyphen, welche die Masse der längs verlaufenden durchflechten und seltener auch zwischen die Elemente der grosszelligen Rinde eindringen". But as he designates the longitudinal filaments also as "Hyphen", it is not clear if it is a case of real hyphæ or only of the above named connecting filaments. As he says, on p. 18, that they occur only "ganz vereinzelt", it seems that he has really observed secondary hyphæ, although in very small number.

This species is only little variable in shape and size. It often reaches a length of 14 cm, even in the Baltic, almost to the limit of its distribution. The largest specimens, 18 cm high, were found in the Skagerak and the South Fyen waters. The depth has no influence on its size, save that when growing at low-water mark it does not become longer than 6 cm. The greatest length is reached in 5,5 to 9,5 meters depth. Adventitious shoots from scars left by decayed ends of frond frequently occur, as in *Furcellaria*, but rarely developing from the surface of the frond.

The species grows on stones, but is frequently met with loose on the bottom, particularly in the *Zostera* formation, but also on bare sandy bottom, as for instance around Anholt, where it occurs in great quantities together with *Furcellaria fastigiata*. It occurs in all the Danish waters, with exception of the eastern Kattegat and the Baltic around Bornholm, from a little below low-water mark to about 11 meters depth. In greater depths it occurs more rarely; certainly it has been found in several places down to 23,5 m depth, but in most cases it was certainly or probably loose. As sure deeper localities may be named, in the Skagerak: off Hanstholm and Lønstrup, 13 m; and in the Kattegat: Tønneberg Banke, 16 m. It does not thrive in fjords; in the Limfjord it has however been found in one locality.

Specimens with tetraspores seem to occur much more rarely than sexual specimens in the Danish waters; I have met them only in one locality in the Skagerak and in two in the northern Kattegat, while female specimens have been found in several places from the Skagerak to the Baltic.

Localities. **Ns**: Ørhage, 2 m. — **Sk**: Hanstholm, 5,5 to 13 m, abundantly in 13 m depth; washed ashore by Blokhus and Svinekløv (P. Petersen); off Lønstrup 8,5—13 m, most well developed in 8,5 m depth; Hirshals, near land 1—4,5 m, in some places dominant. — **Lf**: Only found on the mole of Lemvig, 6 cm long. — **Kn**: Harbour of Skagen; Hirsholmene; Krageskovs Rev; Frederikshavn; N. Rønner 1—5,5 m; several places north of Læsø, 2—9,5 m; Trindelen, about 18,5 m; Tønneberg Banke, 16 m. — **Km**: NE, NW of Fornæs; around Anholt, abundantly loose. — **Ks**: Hesselø (Lyngbye). — **Sa**: PN (Kaløvig); PE (Refsnæs); Hofmansgave (Hofman Bang, J. Vahl, C. Rosenberg): OA (Æbelø). — **Lb**: AX (Bjørnsknude), 9,5 m; Middelfart (Rasch, !); Fænø Sund, 1 m; DF; CC; DB; UX. At several places it reaches a length of 18 cm. — **Sf**: CU. — **Sb**: GQ; harbour of Kerteminde; DO; Y; UR. — **Su**: North of Helsingør (Liebman, Joh. Lange, !); Taarbæk Rev; RK; PS, off Charlottenlund. — **Bw**: UY¹, 18 m, probably loose. LC (Gulstav); South of Nysted. — **Bm**: QM (Juels Grund); washed ashore at Stevns.

Fam. 7. Squamariaceæ.

Petrocelis J. Agardh,

1. *Petrocelis Hennedyi* (Harvey) Batters.

Batters in Holmes Alg. Brit. Exsicc. No. 89 (non vidi), Mar. Alg. Berw. Tweed, 1889, p. 94, tab. XI, fig. 3—4.

Actinococcus Hennedyi Harvey, Natural History Review, Vol. 4, 1857, p. 202, pl. 13A, fig. 1 (non vidi).

Cruoria pellita Lyngbye Hydroph. 1819, p. 193, tab. 66 ex parte, teste specim.

Chætophora pellita Flora Dan. tab. 1728, 1821.

Petrocelis Ruprechtii Hauck Meeresalg. 1883, p. 30.

The species forms dark-red fleshy crusts, in a dried state glossy, 1—3 cm in diameter. The basal layer is a monostromatic disc composed of radiating filaments.

The margin is somewhat lobed, and the filaments of the basal layer radiate towards the border of the lobes (fig. 92 A). When the surface of the substratum is uneven, small rudimentary rhizoid cells may be given off from the basal layer (fig. 92 C). Fusions between the cells of this layer have not been met with. The upright filaments which are given off from the acroscopic end of the cells in the basal layer are decumbent at the base, so that there often seem to be more than one layer of basal cells. At the border the filaments are directed obliquely forwards. The upright filaments have almost the same thickness in the upper and the lower part

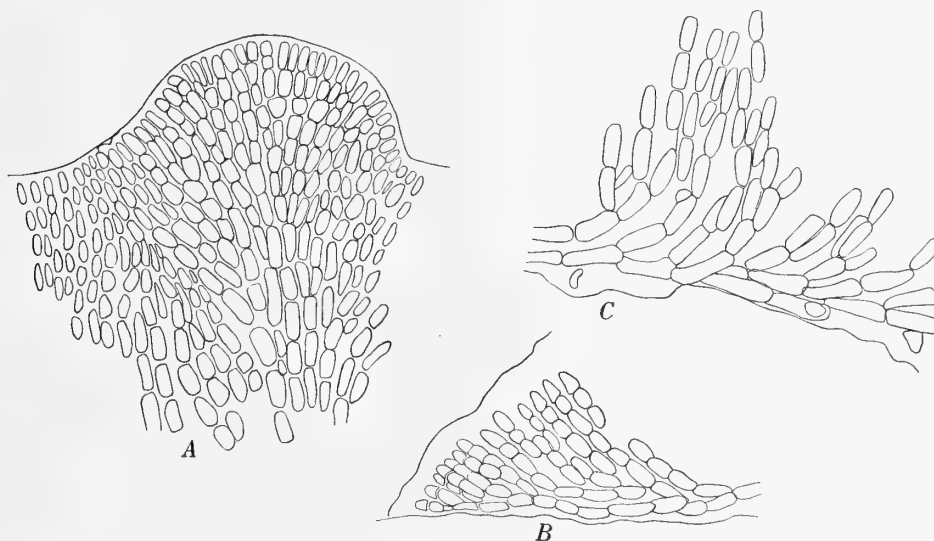


Fig. 92.

Petrocelis Hennedyi. A, basal layer seen from the under face (230:1). B, vertical section of border of frond. C, vertical section of older part of frond. B and C 390:1.

of the crust; in the upper part they are 4–6 μ thick. They are imbedded in a glutinous intercellular substance which swells greatly in fresh water, whereby the filaments are separated. The upper end of the filaments is nearly always a little attenuated, the uppermost cell usually being narrower than the other, and more or less conical, or the upper part of the filament is gradually tapering (fig. 95). In some cases, however, particularly in thin crusts, I found the filaments of the same thickness to the very end (fig. 96). The cells are usually twice or thrice as long as broad, they contain a nucleus and a cap-shaped chromatophore with more or less lobed border; in a specimen examined in July the cells contained numerous small starch grains. The upright filaments are simple or little branched. The ramification is lateral, subdichotomous or sometimes sympodial; the latter reminds one of the false ramification of the Cyanophyceæ, the penultimate cell growing out and throwing aside the apical cell, which does not usually develop further. In fig. 93 B the wall of the outgrowing cell is seen to have been burst. Hyaline

hairs are sometimes found given off from intercalary cells in the vertical filaments. The cells producing them are usually more or less projecting, but the hairs are feebly developed; they do not ordinarily reach the surface of the frond, and soon decay.

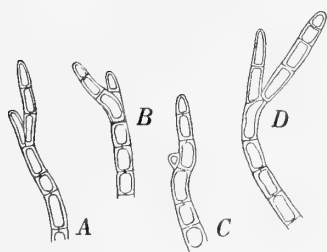


Fig. 93.

Petrocelis Hennedyi, from the Limfjord (ZY), showing peculiar ramifications of vertical filaments. 390. 1.

Once only have I seen a few such hairs projecting over the surface, as in fig. 94 *E* where the hair, however, is terminal on a one-celled branchlet¹. — The crusts may certainly reach an age of more than one year. In crusts growing on stems of *Laminaria hyperborea* a stratification is often visible which seems to be due to the cessation of the growth in winter; in the part of the crust beneath the limiting line empty or abortive fructifications may be found, while new fructifications have not yet been produced in the upper part of the frond apparently formed after the hibernal rest.

Characteristic of the genus are the intercalary sporangia. In this species there are as a rule several consecutively in the same filament, in Danish specimens frequently six at least in a row, but there may be up to nine. The row is never interrupted by sterile cells. The sporangia are situated in the upper part of the vertical filaments, only the (1—) 2—5 uppermost cells being sterile. The sporangiferous vertical filaments are usually unbranched, but sometimes a branch is given off, rarely from the articles transformed into sporangia, more frequently from the cell subjacent to the sporangial series (fig. 95). The sporangia are first divided by an inclined transverse wall and then by two walls perpendicular to the wall first formed. The latter are frequently parallel, but the lines of intersection with the transverse wall do not coincide. These seriate sporangia

are of about the same height as breadth, 14—17 μ broad, 16—23 μ high.

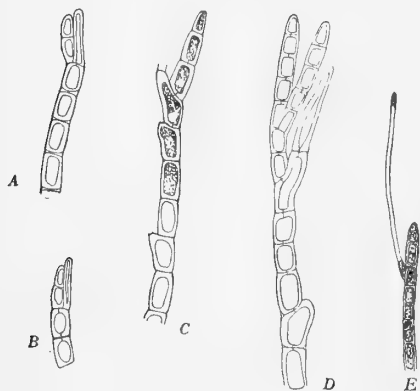


Fig. 94.

Petrocelis Hennedyi. Vertical filaments with hyaline hairs. A—C from Begtrup Vig; in C the hairs have been thrown off, the chromatophore of the cells is visible. D—E from Hellebæk, E after a living plant with a well developed hair at the top of a unicellular branchlet. A—D, 400:1; E, c. 200:1.

In most of the crusts only seriate sporangia are present; but in some cases the sporangia were single or at most two in a series. These sporangia are more lengthened than the seriate ones. A transitional case is shown in fig. 95 *D*, where the series contains only two sporangia. But in fig. 95 *G* and *H* single, terminal or subterminal sporangia are represented. In fig. 95 *H* the sporangium seems to be terminal, but I cannot assert that there has not been one or more sterile cells which may be decayed or possibly removed by the preparation. Similar sporangia were found in a thin crust with the ends of the filaments truncate; fig. 96 shows

¹ Comp. L. KOLDERUP ROSENVINGE, Hyaline hairs (Biol. Arbejder, tilegn. E. Warming, 1911, p. 206).

at left a sporangium with a single small sterile cell at the top and at right an apparently terminal sporangium. There is no doubt that the sporangia here mentioned are transformed cells of the filaments in which they are situated; this is more doubtful in the case represented in fig. 95 *I*, where the sporangium has the appearance of being lateral, but as it has been found in the same crust as those figured in fig. 95 *F–H*, it must be supposed that it has really been terminal. The single sporangia are 2 to 3 times as long as broad, 26–50 μ long, 11–14 μ broad. Their great length depends probably on their terminal or subterminal place, which permits them to develop unhindered by sporangia or sterile cells lying above. In some crusts only such lengthened sporangia, singly or in pairs, are found; in others they are found in company with the ordinary seriate ones, as a rule, however, in different parts of the frond. By this fact it is shown that the two kinds of sporangia really belong to the same species. Single sporangia have been met with in three places in spring (*Ks*: Hastens Grund; *Sa*: Rønne in Begtrup Vig and *Lb*: off Middelfart).

There is no resemblance between the single sporangia of this species and those of *Petrocelis cruenta* J. Ag., which are strictly intercalary and globular (comp. LE JOLIS Alg. mar. Cherb. pl. III, fig. 4).

In specimens gathered in November in the Great Belt I have found spores germinating in the seriate sporangia (fig. 95 *E*). The spores were divided by variously orientated walls and some of the uppermost resulting cells were growing out upwards into filaments.

The antheridia arise in the upper part of the vertical filaments, where they form small lateral bushes, rather similar to those of *Cruoria*. They are borne on the upper end of small, usually unicellular, more rarely bicellular, branchlets, two

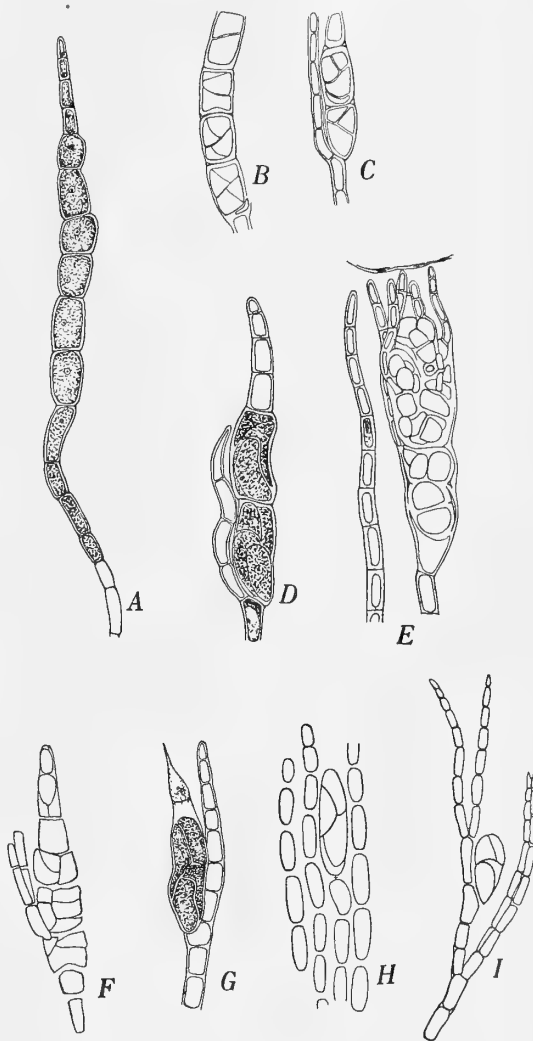


Fig. 95.

Petrocelis Hennedyi. Vertical filaments with tetrasporangia. *A*, six still undivided sporangia, November. *B* and *C*, ripe sporangia, July. *D*, filament with two sporangia only, April. *E*, tetraspores germinating in the sporangia, April. *F–I*, from Begtrup Vig, May, *F* with seriate sporangia, *G* with subterminal, *H* and *I* apparently with terminal sporangia (in *I* possibly lateral?). *A, D, E, G, H* 390:1 *B, C, F, I*, 300:1.

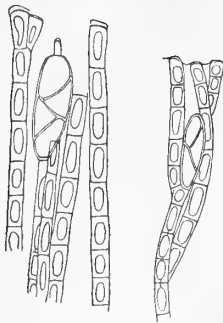


Fig. 96.
Petrocelis Hennedyi, thin crust from Lillebelt, March. Vertical filaments with truncate end-cell. Sporangia subterminal or terminal. 390:1.

or three on the same stalk (fig. 97). Sometimes they appear to be produced directly from a cell of the vertical filament.

The carpogonial branches are situated laterally on the vertical filaments. They are somewhat variable in shape and number of cells. Usually they are two-celled, and the undermost cell then frequently projects considerably downwards beyond the insertion point (fig. 99 A).

More rarely the carpogonial filament is 3-(or 4)-celled. A carpogonium situated directly on the vertical filament was also met with, but the cell from which it was given off had in this case the character of the cells of carpogonial branches (fig. 98 A), its contents being more homogenous and staining more intensely by

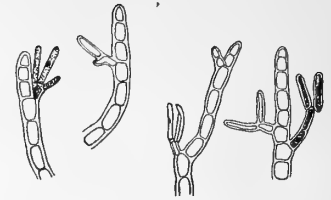


Fig. 97.
Petrocelis Hennedyi, from the North Sea (Klitmøller), August. Vertical filaments with antheridia. 390:1.

hæmatoxyline than the ordinary cells. This may also sometimes be the case with the cell bearing 2-celled carpogonial branches (fig. 98 B). The cell bearing a carpogonial branch is frequently swollen, resembling the auxiliary cells.

The auxiliary cells arise from single cells in the vertical filaments, which become somewhat swollen and more susceptible to colouring matter. They appear to arise in some cases from cells having produced a hair (fig. 98 G, H). The development of the cystocarps has not been followed; I have only observed a few stages succeeding the presumed

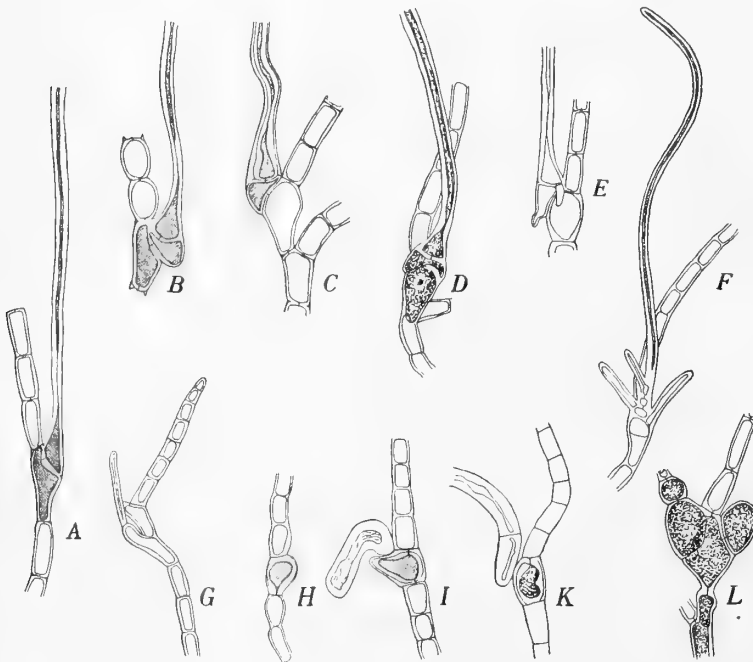


Fig. 98.

Petrocelis Hennedyi, from Bornholm, July. A, carpogonium situated directly on the vertical filament. B-D, two-celled carpogonial branches; in B and D the supporting cell has the same character as those of the carpogonial branch. E, carpogonial branch with short sporogenous filaments given off from the carpogonium and the subjacent cell. F, carpogonial branch producing (sporogenous?) filaments. G, vertical filament with two larger cells, one of which bears a hyaline hair. H, vertical filament with a presumed auxiliary cell with scar after a decayed hair. I and K, auxiliary cells in contact with sporogenous filaments. L, probably young gonimoblast. A-E and L, 630:1 F-K 390:1.

fertilization¹. Sporogenous filaments are found given off not only from the carpogonium but also from other cells in the carpogonial branch; in the latter case, however, fusion between these cells and the carpogonium could not always be discerned, as for instance in fig. 98 *E*, where two young sporogenous filaments are seen projecting from the carpogonium and the subjacent cell. Older stages are shown in fig. 99 *C* and *E*; in *C* the filaments causing the fusion between the cells of the carpogonial branch are easily visible. The sporogenous filaments are here seen growing out in a horizontal direction from the carpogonial branches. Fig. 98 *I*, *K* show auxiliary cells in contact with sporogenous filaments, and fig. 99 *G* represents probably the same after the fusion. The stages shown in figs. 99 *D* and 98 *L* are probably young gonimoblasts, though sporogenous filaments are not visible. Ripe cystocarps are shown in figs. 99 *H*, *I*; they consist, as shown by Batters (l. c. pl. XI, fig. 4), of an almost spindle-shaped heap of carpospores which easily segregate on preparation. The spores are 14 to 17 μ in diameter.

The species has been found in almost all the Danish waters, in depths of 1 to 19 meters. It grows on stones and shells of *Mytilus edulis* and *Littorina littorea*, often in company with incrusting *Lithothamnium* and growing over them. In the North Sea and Skagerrak it has principally been found growing on the stem of *Laminaria*

hyperborea. The sporangia begin their development as a rule in the autumn; they were found undivided in September and November, ripe in January to July, emptied or abortive in June to September and November. But young sporangia

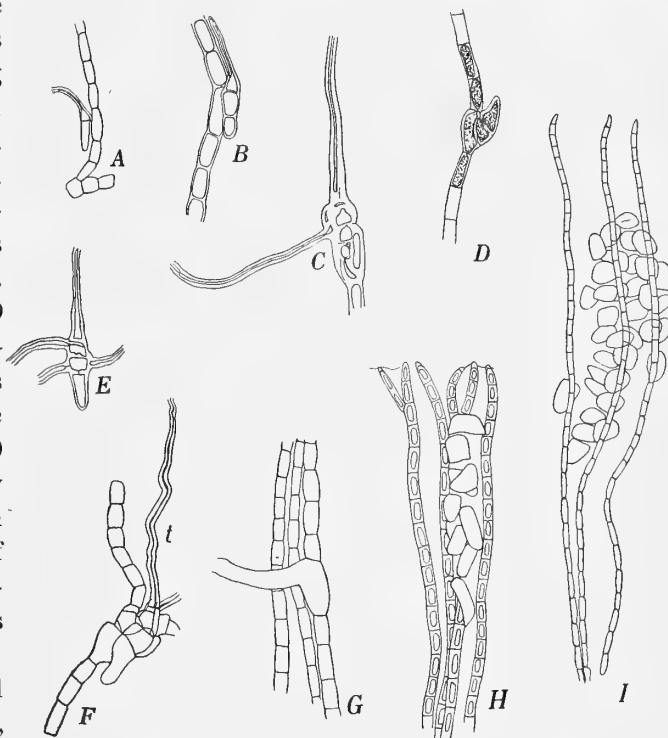


Fig. 99.

Petrocelis Hennedyi. A, two-celled carpogonial branch, January. B-D, Begtrup Vig, May. B, three-celled carpogonial branch, unfertilized. C, carpogonial branch after fertilization (?), giving off sporogenous filaments. D, young gonimoblast arising from an auxiliary cell (?). E, carpogonial branch giving off three sporogenous filaments (Skagerrak, April). F-G, Hellebæk, July. F, carpogonial branch giving off sporogenous filaments. G, presumed auxiliary cell fused with a sporogenous filament. H, cystocarp, not fully developed, Lysegrund, May. I, ripe cystocarp, Storebelt, January. A, H 300:1. B-G 390:1. I 230:1.

¹ Spermatia have not been found adhering to the trichogynes, and in some cases carpogonia having produced sporogenous filaments show no interruption of the protoplasm over the ventral part (fig. 98 *E*, 99 *E*) which might suggest a parthenogenetic development of the cystocarp.

were also met with in July. The antheridia have only been met with in particular male specimens from the North Sea and the Limfjord, collected in August, and a cystocarp-bearing specimen from Lillebelt collected in July also appeared to bear emptied antheridia. The cystocarps develop, as it seems, at about the same seasons as the tetrasporangia. They have been found ripe in January, May and June, emptied or degenerated in August. The carpogonia seem to arise at various seasons. In specimens collected in November I have found very young carpogonia still without trichogynes, but in crusts collected at Bornholm in July carpogonia with long trichogynes, partly also with sporogenous filaments, were met with (fig. 98), and unfertilized and fertilized carpogonia (at all events producing sporogenous filaments) have also been found in spring. In some cases sporangia and cystocarps have been found in the same crust.

Localities. **Ns**: Klitmøller, on the stem of *Laminaria hyperborea* washed ashore; Hanstholm (YU), 2 meters. — **Sk**: 4 miles N¹/₄E of Svinkløv beacon (A. C. Johansen); Løkken, on Lam. hyp. on the shore; off Lønstrup, about 9 m; off Hirshals, on Lam. hyp. — **Lf**: Nissum Bredning off Helligsø, 6 m (C. H. Ostenfeld); at Mullerne (ZY), 4,5 m; Søndre Røn near Lemvig; Holmtunge Tange (MK). — **Kn**: Krageskov Rev (TV). — **Ke**: JO, Fladen; OO, Søborghoved Grund, 8,5 m. — **Km**: XC, NW of Anholt. — **Ks**: OS, OS¹, Hastens Grund, 14—16 m; HQ, Lysegrund; EJ, entrance to Isefjord. — **Sa**: GD, near Sejerø; FS, Vejrø Sund; Rønne in Begtrup Vig, 1 m; North side of Refsnæs Reef, 13 m, (Ostenfeld); DK, Bolsaxen; MQ, South of Paludans Flak, 12 m; Halsgab near Hofmansgave, "in saxis maris Hindsholm" (Lyngbye, Hofman Bang); DJ, east of Æbelø. — **Lb**: FZ, Kasserødde, 6,5 m; North of Fænø Kalv; off Middelfart, about 15 m. — **Sb**: Stavreshoved; GP, Halskov Reef; NN, SW of Sprogø, 19 m; Avernakhage near Nyborg, 2 m; GZ, north of Egholm; DN, Vengeance Grund; near Vresen (Ostenfeld); DP, north of Onsevig. — **Su**: BQ, off Ellekilde, Ellekilde Hage, 11 m; North of Lappegrund, about 20 m (H. E. Petersen). — **Bw**: DU, off Dimesodde, 11 m. — **Bm**: QQ, off Rødvig. — **Bb**: YG, Arnager Rev, 7 m.

Cruoria (Fries).

1. *Cruoria pellita* (Lyngb.) Fries, Areschoug.

El. Fries, *Corpus florar. prov. Suec.* I. 1835, p. 317; J. E. Areschoug, *Algarum pug. sec. Linnæa*, Vol. 17, p. 267, tab. IX fig. 6—8, 1843, ex parte, *Phyceæ scand. mar.*, 1850, p. 157; *Alg. scand. exsicc.* No. 309 (1872); J. Agardh, *Sp. II*, 1852, p. 491, III, 1876, p. 377; Le Jolis, *Liste alg. Cherbourg* p. 108, pl. IV, fig. 1—3; Batters, *Mar. Alg. Berw.* 1889, p. 95, pl. XI fig. 5.

Chatophora pellita Lyngbye *Hydr.*, 1819, p. 193, pl. 66 B, ex parte (quoad specim. færoëns.).

Cruoria adhærens Crouan in J. Agardh *Sp. II*, p. 491, III, p. 377, (comp. Le Jolis, *Liste*, p. 108).

An examination of the specimens of *Chatophora pellita* in LYNGBYE's herbarium has shown that this name includes two distinct species, the specimens from the Færøes belonging to *Cruoria pellita*, while those from Denmark belong to *Petrocelis Henedyi* (comp. p. 174). The description and the figures, which treat only of sterile specimens, agree tolerably well with both species; it appears most probable, however, that they have been worked out after the Danish specimens, as the filaments in the fig. 2 are not thicker towards the base, and as they are described as "æqualia, apice parum attenuata" (l. c. p. 194), which agrees best with the last

named species. The genus *Cruoria*, to which the species of LYNGBYE was referred in 1835 by FRIES, was also very ill defined. ARESCHOUG and the later authors, however, have applied the name of LYNGBYE and FRIES to the species here treated of, and it must be used in the future in the same sense, as the specific name of LYNGBYE in fact comprises both species.

This species, in habit quite resembling *Petrocelis Hennedyi*, forms crusts on the stems of *Laminaria hyperborea*, stones, shells of *Mytilus* and barnacles, more

rarely on *Fucus serratus* and the basal part of *Halidrys siliquosa*, from 1 to 12 cm in diameter or more. The crust has at first a basal layer consisting of one layer of cells from which the vertical filaments are given off. The fila-

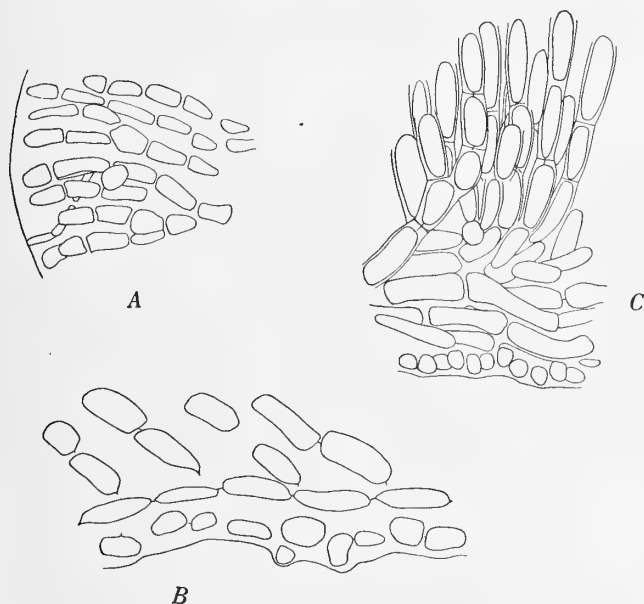


Fig. 100.

Cruoria pellita. A, border of frond seen from above. B, vertical section of under part of frond showing basal layer and sub-basal layer. C, similar, older crust. A, B 390:1. C 230:1.



Fig. 101.

Cruoria pellita. Basal layer of frond seen from the under face, showing creeping rhizoidal filaments. 390:1.

ments of the basal layer are radiating towards the margin (fig. 100 A). According to SCHMITZ and HAUPTFLEISCH (1897, p. 535) the thallus is quite coalesced with the substratum and without root-hairs (Wurzelhaare); the first is true, but the latter assertion is not quite correct. As shown in figs. 100 and 101, short filaments are here and there given off from the under side of the basal layer; these filaments have first the character of unicellular rhizoids, but increase in length and form long septate filaments running under the primary basal layer, and in older crusts they may form a continuous layer consisting of one to more layers of variously disposed cells, the undermost of which may have the character of rhizoids penetrating into the unevennesses of the substratum, while the upper cells in thicker fronds resemble those of the primary basal layer. According to SCHMITZ and HAUPTFLEISCH (l. c.), rhizoids are frequently produced in the undermost part of the cortical layer.

The vertical filaments are ascendent at the base; they are thicker near the base than in the upper part, and consist there of somewhat swollen cells, about $12.5\text{--}14\ \mu$ thick, while the cells of the upper part are $6\text{--}11\ \mu$, frequently $7.5\text{--}9\ \mu$ thick.

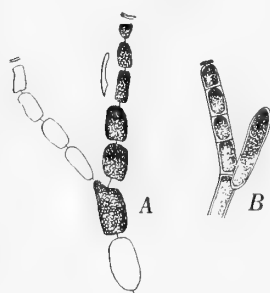


Fig. 102.

Cruoria pellita. A, vertical filament with branch, above a carpegonium (?); the cells contain a chromatophore and starch grains. B, vertical filament with young sporangium. 300:1.

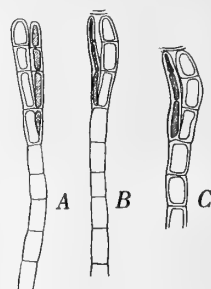


Fig. 103.

Cruoria pellita. Branches consisting of narrower cells with refringent contents. 300:1.

The lower part of the filaments tapers gradually upwards, while the upper part is usually of equal thickness. The ultimate cell is truncate or rounded, but never pointed. The cells contain a nucleus and a single calotte-shaped chromatophore, the border of which seems to be more or less lobed. The cells, particularly those of the undermost part of the filaments, are usually filled with starch grains. The filaments are sparingly branched, by lateral ramification (fig. 102 A). Hyaline hairs were not observed, but I sometimes found septate branches thinner than the filaments and with

more refringent contents, reaching the same level as the ordinary filaments (fig. 103).

The tetrasporangia and the sexual organs occur as a rule in distinct individuals; carpegonia have, however, been met with in tetrasporangia-bearing crusts. The tetrasporangia are lateral on the vertical filaments. As shown in the figure published in Le Jolis' Liste (l. c.) they are attached in such a manner that their under part projects below the point of attachment. They are very large and divided by three horizontal walls. In specimens from Frederikshavn they were $250\text{--}283\ \mu$ long, $45\text{--}60\ \mu$ broad. A young sporangium is shown in fig. 102 B. In one case the spores seemed to contain several nuclei, but the observation was not certain, owing to the numerous starch grains contained in the spores.

The antheridia form small lateral tufts at the upper end of the vertical filaments, as shown by THURET (LE JOLIS l. c. pl. IV fig. 3). They are usually produced in small numbers on the upper end of a unicellular branchlet (fig. 104). The antheridia are linear, but the liberated spermatia, according to THURET (l. c.) are globular. I have only once observed antheridia, in a specimen collected at Frederikshavn in July, having also carpegonia and cystocarpia.

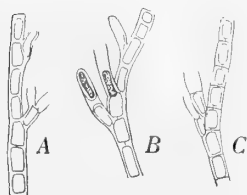


Fig. 104.

Cruoria pellita. Upper ends of filaments with antheridia, mostly emptied. 390:1.

The development of the cystocarps has only been incompletely followed. The carpegonial filaments are lateral on the vertical filaments. Their number of cells may be variable, at most four (fig. 105 A), more frequently less, e. g. two in fig. 105 B, and in fig. 106 A, where the trichogyne reached over the surface of the frond. Most of the carpegonial filaments observed had short trichogynes, and were probably young or abortive. Carpegonia sitting directly on the vertical filaments also occur, but in such cases it was often difficult to decide whether they

were really carpogonia. Such dubious cases are shown in fig. 105 C, D; I have been inclined to interpret them as carpogonia, since they had the same refringent and colourless contents as the others. In some cases the supporting cell in the vertical filament had a similar appearance (fig. 105 C, D) (Comp. *Petrocelis Hennedyi*, p. 178). The undermost cell in the carpogonial filament is sometimes connate in its whole length with the supporting filament. Sporogenous filaments were not seen in connection with the carpogonium, but they were found fusing with the auxiliary cells. These cells are intercalary in the vertical filaments and differ but little from the other cells, possibly sometimes swollen before fusion. The sporogenous filaments run principally in a horizontal direction, but sometimes give off upward branchlets,

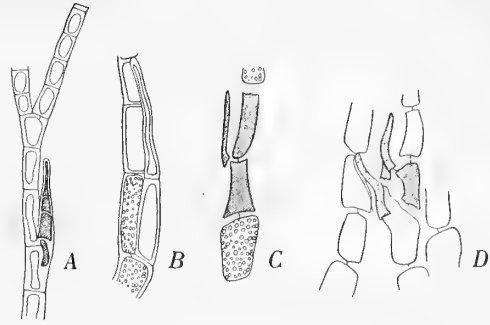


Fig. 105.

Cruoria pellita. Carpogonia A, four-celled carpogonial branch. B, two-celled carpogonial branch. C, presumed carpogonium sitting directly on the vertical filament; the supporting cell and the next following have the same homogenous and refringent contents as the carpogonium. D, Carpogonia given off directly from the vertical filament. A, D 300:1; B, C 390:1.

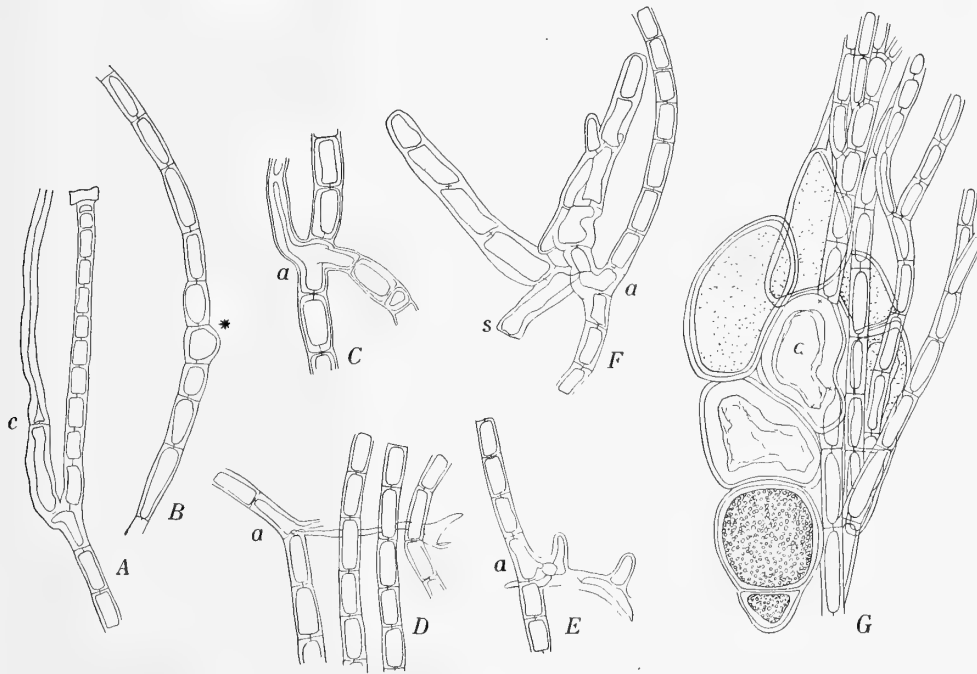


Fig. 106.

Cruoria pellita. A, two-celled carpogonial branch. B, filament with a somewhat swollen cell *, possibly an auxiliary cell. C, auxiliary cell fused with sporogenous filament. D, similar; the sporogenous filament has given off a branchlet upwards. E, auxiliary cell fused with a sporogenous filament which has given off two upwards directed branchlets. F, auxiliary cell in connection with an incompletely developed cystocarp. G, ripe cystocarp; the pits connecting the auxiliary cell with the neighbouring cells in the vertical filament are marked with a x. c, carpogonium; a, auxiliary cell; s, sporogenous filament. A-F 390:1. G 300:1.

the signification of which is unknown (fig. 106 *D, E*). An incompletely developed cystocarp is shown in fig. 106 *F*, it consists of a very small number of upwardly directed filaments, which have been somewhat displaced by pressure; the auxiliary cell has produced a lateral outgrowth, but is otherwise not swollen. Fig. 106 *G* shows a ripe cystocarp; the auxiliary cell, or better, the fusion cell, is here seen as a large cell connected by pits with the neighbouring cells of the vertical filament. All the cells of the cystocarp seem to produce a very large carpospore. The ripe cystocarp consists of a spindle-shaped heap of large cells, few in number, reaching downwards considerably beyond the insertion of the auxiliary cell; it has earlier been shortly described and figured by Batters (l. c.).

The species occurs from low-water mark down to 30 meters depth. In some places in the eastern Kattegat it occurs abundantly, covering the stones with extensive crusts, forming an association. The sporangia arise in autumn; they are found ripe in winter and spring, emptied in spring and summer. Carpogonia were met with at all seasons, often abortive however; cystocarps have only been met with once in July.

Localities. **Sk**: Off Lønstrup (ZK²), on *Laminaria hyperborea*. — **Ku**: Herthas Flak (l, Børgesen); TX, at Hirsholmene; Krageskovs Rev; Busserev at Frederikshavn; harbour of Frederikshavn; VU, east of Nordre Rønner, 15 m; TO, TP, Tønneberg Banke, 16–18 m; FF, TR, Trindelen. — **Ke**: IR, IT and VZ, Groves Flak, 24,5 m; IQ, ZE¹, Fladen; II, IK, Lille Middelgrund; Store Middelgrund (Børgesen), 30 m; IA, Store Middelgrund, 16 m; OO, Søborghoved Grund. — **Km**: XC, NW of Anholt, 11 m, on the base of *Halidrys*; D, north of Isefjord, on *Fucus serratus*, 11 m. — **Sa**: BF, off Sletterhage, 14 m; PH, Lindholms Dyb, 20,5 m; Northside of Refsnæs (C. H. Ostenfeld), 19 m; DK, Bolsaxen, 14 m. — **Lb**: CC, South side of Hornenæs, on *Mytilus*, 7,5 m. — **Sb**: NN, Southwest of Sprogø, 19 m. — **Su**: bM, South of Hveen.

Cruoriopsis Dufour.

Dufour, Elenco delle Alghe della Liguria, Genova 1864, p. 35 (non vidi), Schmitz and Hauptfleisch in Engtl. u. Prantl. I.₂ p. 535.

1. *Cruoriopsis danica* sp. nov.

Crusta sanguinea, diametro c. 2–3 mm, ad 74 μ crassa. Stratum basale unistratosum, substrato arcte adnatum, e filis radiantibus compositum, cellulis 4–9 μ plerumque c. 6–9 μ latis, c. 6–7 μ altis, latitudine plerumque c. duplo longioribus, nonnunquam lateraliter confluentibus. Fila erecta 4–7-cellularia, æqualia vel in inferiore parte nonnunquam sursum paulo attenuata, 5–11 μ lata, cellulis longitudine vario, inferioribus nonnunquam non nisi dimidiam partem latitudinis attingentibus, superioribus latitudine sæpe duplo longioribus, chromatophorum singulum continentibus. Pili hyalini terminales nonnunquam sparse occurrunt. Sporangia in filis erectis terminalia, solitaria, rarius bina, ellipsoidea, 23–30 μ longa, 14–18 μ lata, oblique cruciatim divisa. Organa sexualia ignota. Cellulæ auxiliariæ (?) brevissimæ in parte media vel superiori filorum seriatae.

The cells of the basal layer form regularly radiating filaments of varying breadth. Lateral fusions may be wanting in some cases, while in others they occur in great

numbers (figs. 107 *I*, 108 *A*). More than two cells may sometimes fuse together. The cells of the basal layer are low, and the same may also be the case with the undermost cells in the erect filaments, while those of the middle and the upper part of the filaments may reach a length of up to 2,5 times the breadth. The erect filaments have almost the same breadth in their whole length, frequently, however, they are a little thicker towards the base, and the uppermost cell may be a little thicker than the second from the top. The filaments are rather firmly connected, but not or only to a slight degree united by a gelatinous collode. In the undermost part of the frond

fusions may sometimes take place between contiguous cells of different filaments, as in the following species. The surface is covered with a rather firm outer wall. Each cell contains a calotte-shaped chromatophore and a small nucleus, little

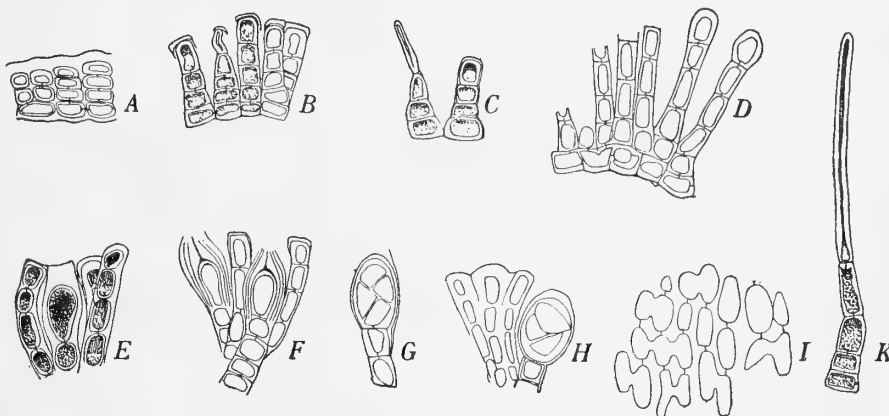


Fig. 107.

Cruoriopsis danica. A—H from M. A—D, vertical sections of frond, in B a young hair, in C, a more developed hair, in D, fully developed erect filaments, a little swollen at the top, E, unripe sporangium. F, new sporangia formed within emptied sporangial walls. G, H, ripe sporangia. I, K from MK. I, basal layer from the face showing fusions. K, erect filament ending in hair. 390:1.

susceptible to staining reagents. The frond is, at all events in some cases, poly-stromatic to the border (fig. 108 *F*).

Here and there some of the erect filaments terminate in hyaline hairs; these occur in varying quantity, usually solitary. They are fairly rich in protoplasm. The subjacent cell is somewhat lengthened, conical (fig. 107).

The sporangia arise from the terminal cell of erect filaments. They reach the surface of the frond and are originally, like the vegetative cells, covered with a thick outer wall (fig. 108). The first wall is inclined, the two following perpendicular to it (figs. 107 *G*, 108 *E*). After evacuation of the sporangium a new one may sometimes be formed from the subjacent cell within the emptied sporangial wall (fig. 107 *F*).

In specimens dredged in the Little Belt in July 1915 I found very short-celled filaments which were supposed to be auxiliary-cell filaments, though carpogonia were not found. They arose from erect filaments, which in a smaller or greater extent of their length consisted of low, disc-shaped cells, the undermost and one, or more rarely two or three, of the uppermost cells showing the ordinary length. The short cells were of a feebler colour than the other cells; they resembled the auxiliary-

cell-rows of several other *Cryptonemiales*, but they seem to be different from those found in *Cruoriopsis cruciata* Dufour, which, according to SCHMITZ (Sitzungsber. d. niederrhein. Ges. für Natur- u. Heilk. zu Bonn. 1879) are lateral and 3- to 5-celled.

As may be judged from the above description, our species much resembles *Cruoriopsis Hauckii* BATTERS, according to the description given in the Journ. of Botany 1896 p. 387 (New or critical Brit. mar. Algæ), and I have indeed been much in doubt, whether it might not be identical with it. BATTERS' species differs however, by the erect filaments consisting to-

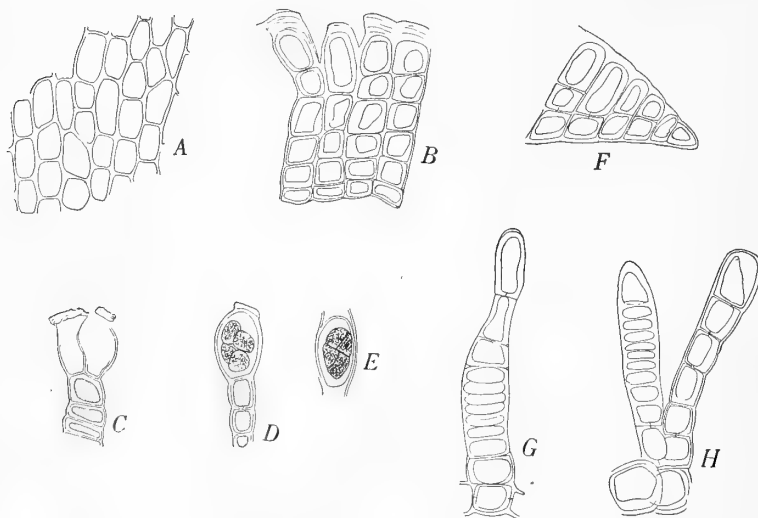


Fig. 108.

Cruoriopsis danica. A—E from Groves Flak. A, basal layer from the face. B, vertical section of frond; at left probably two young sporangia. C, two emptied sporangia on the end of a filament. D, E, ripe sporangia. F—H, from Lille Belt; F, vertical section of the margin. G, H, supposed auxiliary-cell filaments. A—E 390:1. F—H 625:1.

wards the apices of longer and narrower cells, three or four times as long as broad and only 4 or 5 μ in diameter, while at the base of the filaments the cells are 10—15 μ in diameter. Nevertheless I should perhaps have referred my plants to the named species, had I not, through the kindness of the late Mr. BATTERS, received from him a microscopical preparation with two sections of a plant designed as *Cruoriopsis Hauckii* Batt. Plymouth 24th

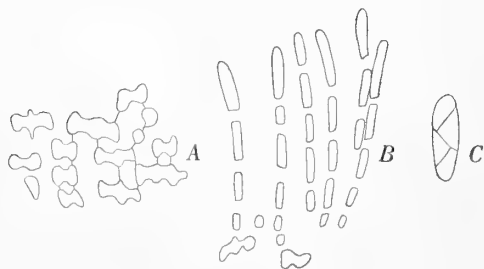


Fig. 109.

Cruoriopsis Hauckii Batt., after preparation sent, from Batters. A, basal layer from the face. B, vertical filaments. C, sporangium. 390:1.

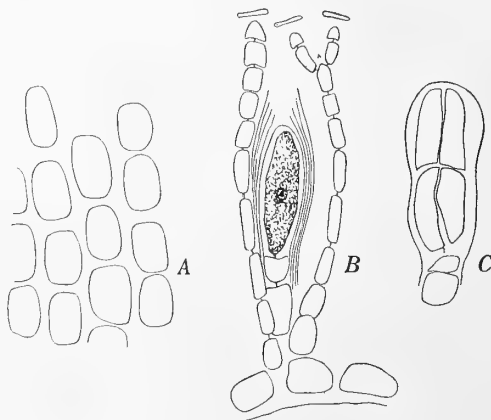


Fig. 110.

Cruoriella armorica Hauck, after specimen from Naples, from Hauck's collection. A, basal layer from the face. B, vertical section, showing unripe sporangium within an emptied sporangial wall. C, ripe sporangium. 390:1.

January 1896, thus apparently a type specimen, but differing from the author's description in the dimensions of the erect filaments and the sporangia, the first being thin in their whole length, $3.5-5\ \mu$ in diameter, not broader at the base, thus much thinner than in our species, and consisting of much more lengthened cells (fig. 109). Further, the crust appeared to have another consistency than the Danish plant, the filaments being connected by a gelatinous substance, while the special membranes of the cells were not distinct. The sporangia were smaller, more lengthened, $18-25\ \mu$ long, $7-11\ \mu$ broad. Hyaline hairs were not present. I think it therefore best to consider the Danish alga as representing a distinct species.

According to BATTERS (l. c.), *Cr. Hauckii* is identical with *Cruoriella armorica* Hauck, Meeresalg. p. 31 (non Crouan). An examination, through the kindness of Mrs. WEBER-VAN BOSSE, of a microscopical preparation of this species from HAUCK's collection, labelled Neapel 1878, has shown me that this plant is different from the Danish, and also from BATTERS' species. The crust is thicker, up to $164\ \mu$, the basal layer consisting of much larger cells, the erect filaments are thinner, more loosely united, sometimes dichotomous above, the sporangia regularly cruciate and much larger, $46-56\ \mu$ long, $26-28\ \mu$ broad (fig. 110)¹.

Cr. danica reminds one not a little of *Cr. arctica* K. Rosenv. (1910, p. 102); it forms, like this, small, thin, blood-red crusts on stones. It differs by lower cells in the basal layer, occasionally fusing with the neighbouring cells, by the presence of hairs, by the oblique division of the sporangia, and by the fact that the sporangia are always terminal, never lateral. It must be admitted that two sporangia may sometimes be found at the end of an erect filament, one of which must possibly be regarded as lateral, but they are in fact both placed terminally on the filament (fig. 108 C), while in *Cr. arctica*, true lateral sporangia occur. Finally, the sporangia are somewhat larger.

The species grows on stones in 1 to 17 meters depth; it has been found with ripe sporangia in April (Groves Flak) and September (Søndre Røn by Lemvig).

Localities. **Lf**: M, Søndre Røn by Lemvig, c. 1 m; MK, Holmtunge Tange, 1—2 m. — **Ke**: North end of Groves Flak (Børgesen). — **Lb**: At Lyngsodde off Middelfart, 15—19 m.

2. *Cruoriopsis gracilis* (Kuckuck) Batters.

E. A. L. BATTERS, Catal. of the Brit. Mar. Algæ (Suppl. to the Journ. of Botany 1902), p. 95.

Plagiospora gracilis Kuckuck, Bemerk. z. mar. Algenveg. v. Helgoland II. Wiss. Meeresunters. N. F. II. Bd. Heft 1, 1897, p. 393.

Cruoriopsis cruciata Batters, New or critical Brit. Mar. Algæ. Journ. Bot. 1896, p. 388.

In July 1915 I found by dredging in the Little Belt near Middelfart a few crusts on stones, agreeing perfectly with the plant described by KUCKUCK under the name of *Plagiospora gracilis*. A few additional remarks may be given here to KUCKUCK's rather short description.

¹ Another specimen in HAUCK's herbarium, labelled *Cruoriella armorica*, from Rovigno was sterile, and evidently belonged to another species, possibly a species of *Cruoria*.

The crusts are thin, bright purple, up to 1,5 cm in diameter. The basal layer consists of isodiametrical cells. The erect filaments are $4,5-5,5\ \mu$ thick. Not unfrequently transversal fusions between contiguous cells in different erect filaments occur (fig. 111 B). The sporangia are normally lateral on the erect filaments and

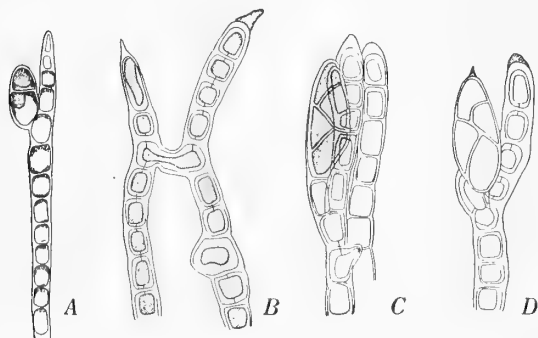


Fig. 111.

Cruoriopsis gracilis. A, erect filament with two-celled sporangium. 430:1. B, fusion between cells of two different filaments. C and D, filaments with sporangia on one-celled stipe. B-D, 730:1.

sessile. In some cases however I found them pedicellate, on a one-celled stipe, as shown in fig. 111 C, D. The sporangia are first divided by an oblique transversal wall (fig. 111 A) and later by two walls perpendicular to the first; at maturity they are $21-22\ \mu$ long, $11-14\ \mu$ broad.

KUCKUCK has established the genus *Plagiospora* on the oblique division of the tetrasporangia. As such divisions occur not only in *Hildenbrandia*, as mentioned by KUCKUCK, but also in *Cruoriopsis* (and further in *Petrocelis*), and as

in the genus *Cruoriopsis* both terminal and lateral sporangia occur, even in the same species (*Cr. hyperborea*), it is justified to refer the species here mentioned to the genus *Cruoriopsis*.

Locality. Lb: At Lyngsodde, right opposite to Middelfart, about 15 meters, with sporangia in July.

Cruoriella Crouan.

1. *Cruoriella codana* sp. n.

Thallus tota superficie inferiori paulum calcaria substrato adhærens, rhizinis unicellularibus affixus, diametro $2-5$ (?) cm latus, purpureus. Stratum basilare (hypothallium) e lobis lateraliter conjunctis e filis flabellatim ramosis compositis formatum, cellulis $14-33\ \mu$ longis, $9-14\ \mu$ latis, $9-11\ \mu$ altis. Thallus adultus e pluribus frondibus superpositis compositus. Fila verticalia frondium singularum plerumque e cellulis $3-10$ formata. — Paranemata nematheciorum sexualium sursum attenuata, e $4-5$ cellulis composita, basi $7-8\ \mu$, superne $2-3(-4)\ \mu$ lata. Anthecidia, in nematheciiis specialibus aut in iisdem ac carpogonia, divisionibus transversalibus et longitudinalibus filorum orta, diametro $2\ \mu$. — Carpogonia in ramulis specialibus $4-5$ -cellularibus terminalia, membrana obliqua curvata a cellula penultima limitata. Cellulæ auxiliariæ in filis aliis intercalariæ. Cystocarpia e filis erectis paucis parce ramosis composita. Carposporæ $11-12\ \mu$ diametro.

The specimens on the base of which this species has been described were for a long time referred by me to *Cruoriella armorica* Crouan¹, a species which has

¹ Ann. d. scienc. nat. 4e sér. t. 12, 1859, p. 289.

often been confounded with other species. It was only by becoming acquainted with the recently published description of *Peyssonnelia* (*Cruoriella*) *Nordstedtii* Weber-van Bosse¹ and by the final revision of my material that I arrived at the conclusion that it was not identical with the former, but more resembled the last named species. As it proved to be different also from this and did not appear to agree with any other well known species, I describe it here as a new species.

Cruoriella codana has only been met with once on a calcareous stone much bored by worms. It forms thin crusts of a bright purple colour, brighter than in *Cr. Dubyi*, and is adherent to the substratum in its whole extent, being fixed to it by unicellular rhizoids. The greatest crust is more than 5 cm in diameter, but it has probably arisen by coalescence of several distinct crusts; the other were at most 1 cm broad. When seen from the underside, the young basal layer appears composed of distinct lobes, which coalesce laterally. The lobes have a flabellate structure. Even when having a continuous outline, the margin is composed of very distinct lobes (fig. 112 A), and the same structure is found in the older parts of the hypothallium, where there are no principal rows of larger cells, as found in *P. Boergesenii* and *P. Nordstedtii* by Mrs. WEBER-VAN BOSSE (l. c. p. 138 and 140). The cells of the basal layer are 14–33 μ long, 9–14 μ broad and 9–11 μ high. Unicellular rhizoids, bounded by a cell wall, are given off from its under face. The marginal cells of the frond divide by vertical cell-walls, and the segments divide immediately by a horizontal wall, the hypothallic cell becoming thus lower than the marginal cell (fig. 114). The monostromatic basal layer or hypothallium is only little distinct from the "perithallium" consisting of the vertical filaments given off from it. These filaments are vertical in their whole extent or slightly ascending; they are only rarely branched. The cells are of almost equal breadth in the same filament, 9–12 μ , or the undermost may be a little broader. Their height is as a rule a little less than the breadth, near the surface sometimes much less, more rarely the same or a little greater. The number of cells in the erect filaments usually varies from 3 to 10.

Old crusts are composed of two or more fronds growing one over the other. At first observation these superposed fronds might be supposed to come into existence in the same way as recently described by Mrs. WEBER-VAN BOSSE in *Peyssonnelia* (*Cruoriella*) *Nordstedtii* (l. c. p. 141, fig. 146), by the formation of a horizontal split in the frond and following constitution of the part situated over the split as a new crust with a new-formed hypothallium. I have seen several cases which were favorable to this interpretation, in particular some apparently young cases and such where the under face of the upper crust was very irregular, and I might suppose that the new upper frond may really arise in this manner. But in other cases it is without doubt that the upper frond arises from horizontal outgrowths from certain parts of the crust which have preserved their growing power, while the covered

¹ Rhizophyllidaceæ in F. BØRGESSEN, Rhodophyceæ of the Danish West Indies. Dansk Botan. Arkiv, Bd. 3. Nr. 1, 1916, p. 140.

parts have lost it by formation of nemathecium or from other causes. The meeting point between the overlapping frond with another similar one or with the forth-growing old frond is usually easily found (fig. 112 *B* *). The places from which the new fronds are given off are frequently inverted conical, being upwardly enlarged and composed of filaments slightly diverging upwards. The number of these

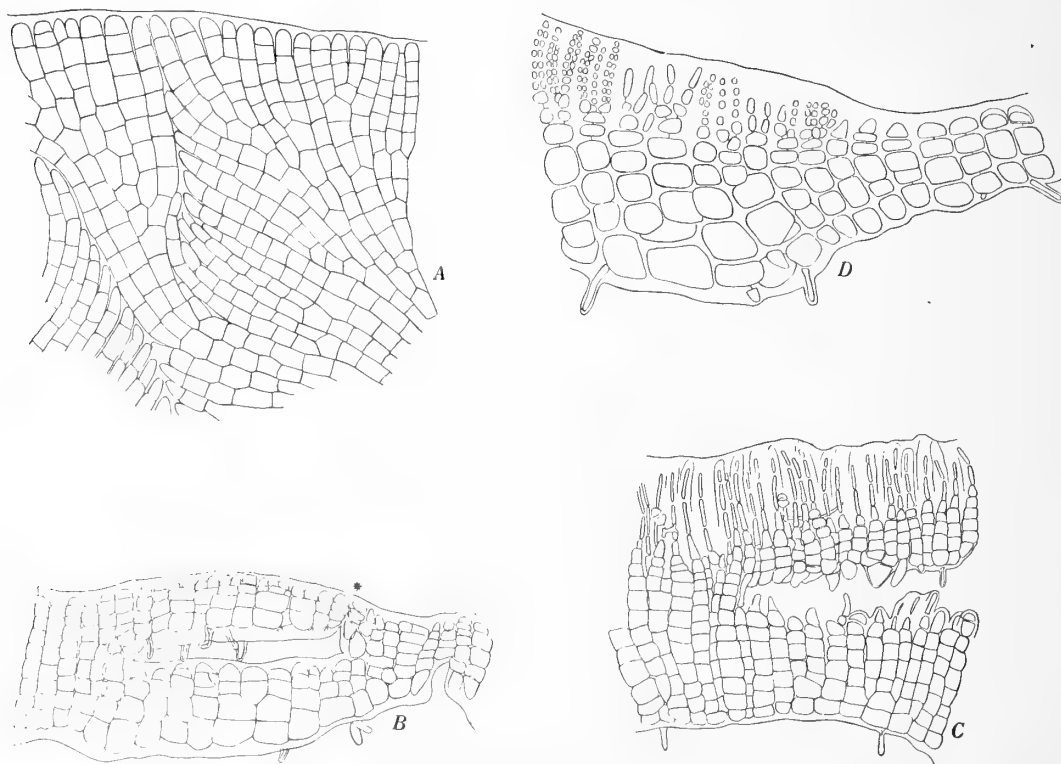


Fig. 112.

Cruoriella codana. A, marginal part of frond seen from below. 195:1. B and C, vertical sections of frond showing the overlapping of the frond by a new lobe; at * the point of concretion of this lobe with another part of the frond; in C the basal layer of the new lobe is not normally developed. In C auxiliary-cell filaments and sporogenous filaments are visible. 205:1. D, vertical section of frond with antheridial nemathecium. 350:1.

points of departure is variable; sometimes they are very close, in other places they are more distant. The new-formed fronds coalesce laterally and form together a uniform plain surface. The cells of the basal layer of the overlapping fronds were frequently found connected with pits, a fact which supports the here proposed explanation of their development. As the new fronds were evidently not produced at the season when the specimens were collected, I have not been able to follow their development, but must content myself with examining the advanced stages. A further fact confirming my view is that nemathecium are frequently found on the surface of the covered crust (fig. 112 C). The under face of the frond is often

irregular; in some places the frond projects downward and, consists there of larger cells, which may here be up to 17μ high.

The cells of the frond contain, as far as could be judged from the examination of dried specimens, a vaulted chromatophore in the upper part of the cell. Numerous starch grains often fill the cells, particularly in the under part of the frond.

The under face of the frond is covered with chalk, but the frond itself does not appear to be incrustated.

The sexual organs are always situated in nemathecium on the upper side of the frond. The nemathecium filaments consist of 4 or 5 cells, the undermost of which have the same breadth as the upper cells of the crust, or about $7-8\mu$, while the thickness of the filaments

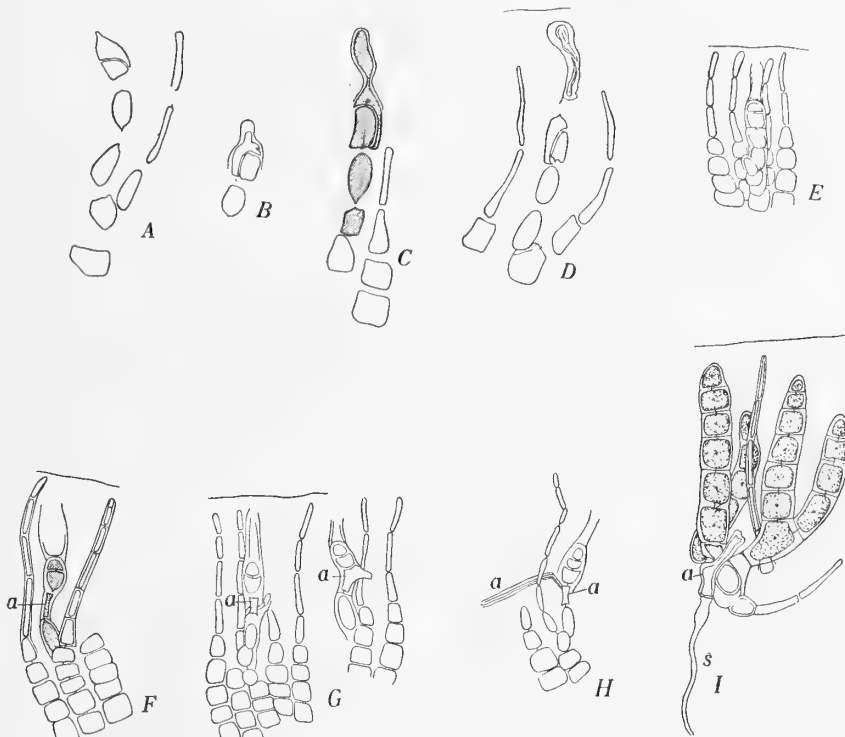


Fig. 113.

Cruoriella codana. A and B, young carpogonia. C, more developed carpogonium with short, thick trichogyne. D, carpogonium showing disjunction of the trichogyne but no other signs of fecundation. E-H, auxiliary-cell filaments; a, auxiliary cell; s, sporogenous filament. I, not fully developed cystocarp; a, auxiliary cell or fusion cell. A-D 630:1. E-I 400:1.

le and in the upper part it is only $2-3(-4)\mu$, without considering the gelatinous outer wall (fig. 112 C). The upper cells are 3 or 4 times as long as broad or even longer.

The antheridia arise from the nemathecium filaments by division of all the cells or with the exception of the undermost one or two cells. The cells are divided by transversal walls or at the same time by longitudinal walls in small antheridial cells (spermatangia), which are about 2μ in diameter; in a longitudinal section each filament appears as composed of one or two longitudinal series of cells (fig. 112 D). The antheridia occur in particular male nemathecium or in the same nemathecium as the carpogonia.

The carpogonia are terminal on 4- or 5-celled branches given off from the lower part of the nemathecium filaments. They are cut off by an oblique curved

wall going from the middle of the longitudinal to the border of the basal wall of the mother-cell. Two young stages are shown in fig. 113 *A, B*. The carpogonium shown in fig. 113 *C* is a little more developed, though yet unfertilized; the trichogyne is short and thick, the carpogonium encloses completely the right side of the hypogynous cell. The carpogonium represented in fig. 113 *D* has the appearance of being fertilized, the continuity of the trichogyne with the ventral part being interrupted, but the carpogonium has not reached the surface of the frond, and no spermatia adhere to it, nor have any sporogenous filaments been formed. Later stages of the carpogonia I have not observed.

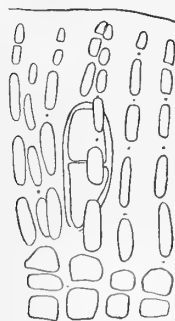


Fig. 114.
Cruoriella codana.
A, vertical section
of margin of frond.
B, vertical section
of sporangial nema-
thecium. 350:1.

The auxiliary cells are more numerous than the carpogonia; they occur in particular branches given off at the base of ordinary nemathecial filaments and are shorter than these (fig. 113 *E-H*). The cells of these filaments have a dense protoplasm and are somewhat swollen, particularly the two uppermost cells, while the third cell from the top (more rarely the fourth) is not swollen. This latter cell is the auxiliary cell, which may be concluded from the fact that it is sometimes found in connection with thin sporogenous filaments running in a horizontal direction between the nemathecial filaments. Over the auxiliary-cell filament a space containing a hyaline substance and provided with a membrane open above is visible; it resembles an abortive hair (fig. 113). The development of the cystocarps has not been followed, but a cystocarp, not quite ripe it is true, but apparently not far from ripeness, is shown in fig. 113 *I*. It consists of a few upward directed, slightly branched filaments, the cells of which each produce a carpospore. In the most developed cystocarp I have seen the carposporal cells were 11–12 μ in diameter.

The sporangial nemathecium, of which I have only observed one, much resemble those of *P. Nordstedtii* (Mrs. Weber-van Bosse l. c. p. 142). The nemathecium had a height of 88 μ , the paraphyses were less tapering than those of the sexual nemathecium, the upper cells being 4 μ broad; the undermost cells were usually 2–3 times as long as broad. The tetrasporangia, fixed at the base of the nemathecium, are certainly cruciately divided, but the ripe sporangia were disturbed by the preparation. Some were divided by a transverse or slightly oblique wall, but the direction of the following walls could not be stated (fig. 114). The almost ripe sporangia are about 50 μ long, 18 μ broad.

As mentioned above, I at first referred the specimens here described to *Cruoriella armorica* Crouan, and I maintained this determination also after having examined, through the kindness of Prof. NORDSTEDT, a type specimen of this species from CROUAN in J. AGARDH's herbarium at Lund (Nr. 27630), having in one specimen found a still sterile nemathecium with thin upwardly tapering nemathecial filaments as in the sexual nemathecium of the Danish species. The sporangial nemathecium, which at that

time were unknown to me in *Cr. codana*, present, however, such differences that it is impossible to identify our species with that of CROUAN, the nemathecial filaments of the latter being forked, fastigiate, and the sporangia being terminal on undivided erect filaments and reaching the surface of the nemathecium, in which respect I found the specimens of CROUAN corresponding to his description and figures.

Our species is apparently related to *Cr. Nordstedtii*, which shows resemblances in the structure of the frond and of the sporangial nemathecia, but there seems to be a difference in the superposed fronds arising only by splitting of the frond in *Cr. Nordstedtii*, while in *C. codana* they seem to arise principally as excrescences from the surface of the frond. The first-named differs further, according to Mrs. WEBER-VAN BOSSE, by the want of principal rows of cells thicker than the others in the basal layer and by the presence of pluricellular rhizoids besides the unicellular ones. The sexual nemathecia are unknown in *C. Nordstedtii*.

It is highly probable that this species has been met with earlier, but confounded with *Cr. armorica*; this, however, cannot be stated without examination of the corresponding specimens.

Locality. **Kn**: TR, near Trindelen, 23,5 meters, September.

2. *Cruoriella Dubyi* (Crouan) Schmitz.

Fr. Schmitz, Syst. Übersicht, Flora 1889, p. 20; id. in Kolderup Rosenvinge, Grønl. Havalger, 1893 p. 783;

Fr. Schmitz und P. Hauptfleisch in Engler u. Prantl, 1897, p. 536.

Peyssonnelia Dubyi Crouan, Ann. sc. nat. III^e sér. t. 2. 1844, p. 367, pl. 11; id., Alg. mar. du Finistère (Exsicc.) 2^e vol. no. 236, Brest 1852; id. Florule du Finistère, 1867, p. 148, pl. 19; HARVEY, Phycol. brit. I, 1846, plate 71; J. AGARDH, Sp. II, 1852, p. 501; III, 1876, p. 384; HAUCK, Meeresalg., p. 35; BATTERS, Mar. Alg. Berw., 1889, p. 90; KUCKUCK, Bemerkungen, II, 1897, p. 393, fig. 18 (antheridia).

The purple-coloured crusts are 1 to 3 (4) cm in diameter. In a dried state they show characteristic radial folds. The outline of the frond is undulate; the course of the cell-filaments in the marginal part is not regularly radiating, owing to its composition of coalescing lobes, the growth being usually arrested in one of the meeting lobes (fig. 115 C). From the underside of the frond, which is covered with a layer of chalk, a varying number of rhizoids are given off; when fully developed they are separated by a wall from the producing cell (fig. 115 A).

The thickness of the frond is variable. As shown in a vertical section, it is divided immediately behind or at a small distance from the border by horizontal walls (fig. 115 A). The cells of the undermost layer, which produces the rhizoids, are usually somewhat lengthened in the radial direction. Two erect cell-rows are frequently given off from one cell in the basal layer or the subbasal layer (fig. 115 B); the cells are therefore greater in the under part of the frond than in the upper. Each cell contains a nucleus and apparently a vaulted chromatophore in the upper part of the cell. To judge from the figure given by KUCKUCK (l. c. p. 394, Fig. 18 B) the chromatophore is either divided into ribbonlike branches or there are several bandlike chromatophores; they are not mentioned in the text. The cells, particu-

larly those of the undermost part of the frond, often contain a great quantity of starch grains taking a brownish colour on treatment with iodine.

Old crusts are often composed of several crusts growing one over the other. This is principally caused, as in the foregoing species, by the cessation of growth of great parts of the fronds, particularly those which have produced nemathecium, while in other parts the erect filaments continue growing in the next season, giving rise to a new frond growing in a horizontal direction over the old frond, and this may be repeated several times, so that old fronds may be composed of 6 or more

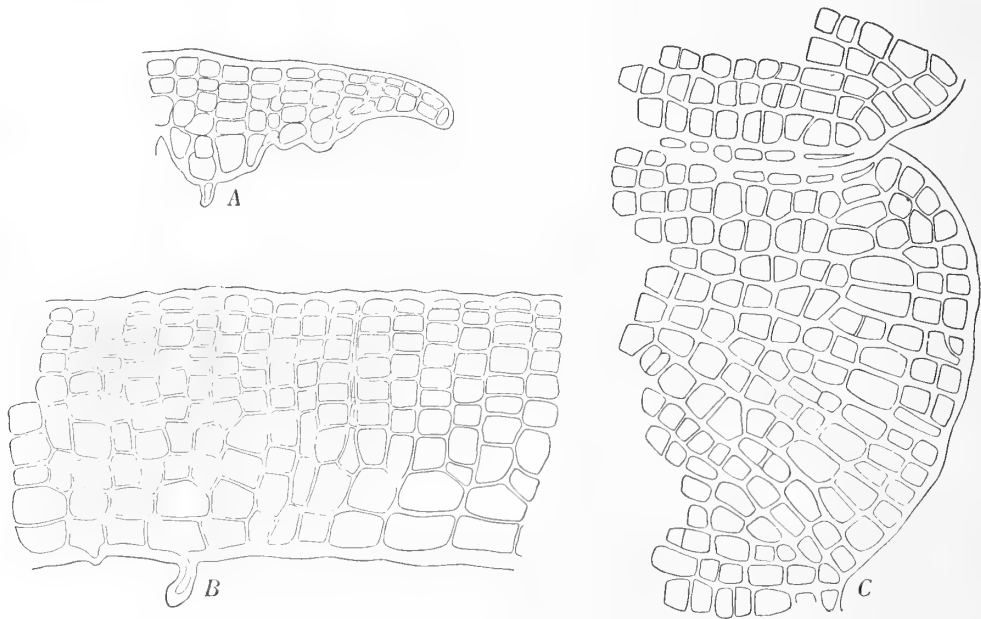


Fig. 115.

Cruoriella Dubyi. A, marginal part of frond in vertical section. B, inner part of frond in vertical section. C, marginal part of frond seen from above. A and B, 295:1; C, 215:1.

distinct crusts. The under side of fronds or lobes thus produced is usually rather irregular (fig. 115 A). Overlapping, though in a smaller degree, may also take place in the border of the frond, where the lobes sometimes grow over one another, and the same may occur on the meeting of two of the fronds produced in the manner first described. A formation of superposed fronds by horizontal splitting, as described for *Cr. Nordstedtii* by Mrs. WEBER-VAN BOSSE may also occur (see above p. 189).

The sexual nemathecium are cushion-shaped, of various extent. The antheridia occur in particular nemathecium or interspersed in the female ones. As shown by KUCKUCK (l. c. fig. 18) the spermatangia arise by transverse and longitudinal divisions of the cells of the nemathecium filaments (fig. 116 A).

The nemathecium filaments of the female nemathecium are of equal thickness in their whole length, and consist at the stage of fertilization of about 5 cells,

which are a little longer than broad; up to twice as long. When the cystocarps are ripe, the cushion is thicker, the filaments somewhat longer, the constituting cells more numerous and sometimes longer. The carpogonia are terminal on particular (3—)4—5-celled branches given off from one of the undermost cells in a nemathecial filament or from one of the bottom cells of the nemathecium (fig. 116). As in the foregoing species, the carpogonium encloses one side of the subterminal

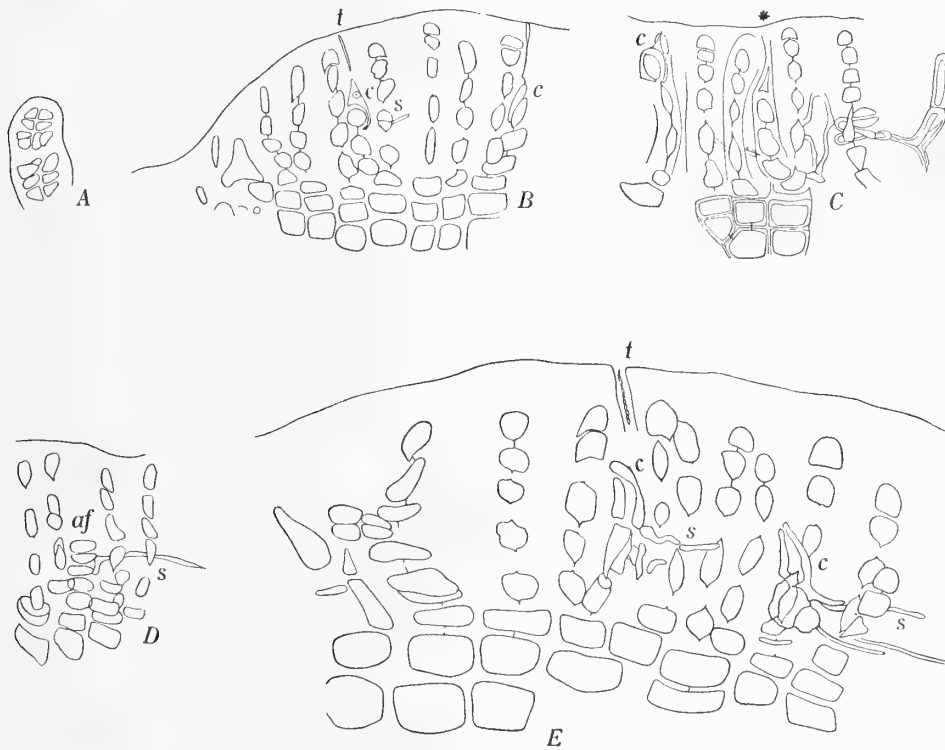


Fig. 116.

Cruoriella Dubyi. A, antheridia, upper part of male nemathecial filament. B—E, vertical sections of nemathecium with carpogonia (c), trichogynes (t), sporogenous filaments (s) and auxiliary-cell filaments (af). A, E 630:1; B—D 390:1.

cell, giving off a production reaching beyond the under face of this cell. In some cases no such lateral production was found, but these carpogonia were doubtless abnormally developed, abortive (fig. 116 C*). The auxiliary-cell branches which are given off from the lowest part of the nemathecial filaments consist of about four low seemingly equal cells. In fig. 116 E two fertilized carpogonia are shown, from which sporogenous filaments growing in a horizontal direction are given off. A similar filament in connection with an auxiliary-cell filament is shown in fig. 116 D. The development of the cystocarp has not been followed. At maturity the cystocarpial nemathecium contains numerous rows of carpospores, each row consisting of up to five almost globular carpospores, each surrounded by a thick hyaline wall.

The carpospores are $19-29\ \mu$ in diameter, with the envelope $35-40\ \mu$; a nucleus is seen in the centre. How many such rows belong to each cystocarp I cannot say; according to BATTERS (l. c. p. 91) each cystocarp consists of one, two or three rows.

Sporangia were only met with in two specimens after evacuation. According to CROUAN, HARVEY and others they are regularly cruciate¹.

The species has been met with in several places from Skagerak to the Samsø waters and the Sound, usually in considerable depths viz. from 13 to 25 meters, in

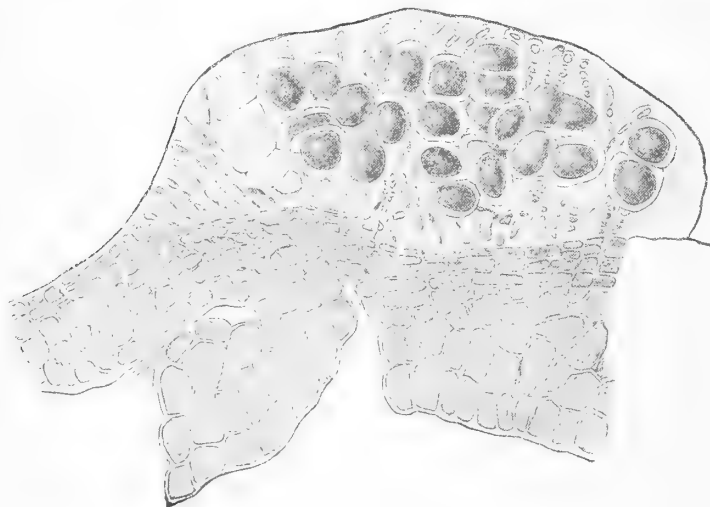


Fig. 117.

Cruoriella Dubyi. Vertical section of nemathecium with ripe cystocarps. 200:1.

Skagerak however also in 2 m and in the Limfjord in 6 meters depth. It grows on stones (granite and flint) and old shells of bivalves (*Cyprina*, *Mytilus modiola* a. o.) and gastropods, and *Serpula*, frequently in company with *Cruoria pellita*. It is perennial, but has only been collected in the months of April to September. Most of the specimens were sterile, but two specimens with emptied sporangia were found in the eastern Kattegat in April and May, and some

collected in the Samsø waters in August had antheridia and carpogonia, partly fertilized, and long sporogenous filaments. Specimens with ripe cystocarps were collected in August off Lønstrup in Skagerak. According to BATTERS it is fructifying in January to June at England's east coast.

Localities. **Sk:** At Roshage, Hanstholm, near land, 2 m; ZK^o and ZK^o off Lønstrup, 7–13 m. — **Lf:** Nissum Bredning, off Helligsø, 5,5 m. — **Kn:** Herthas Flak; Bøchers Banke, 29 m; TO, Tønneberg Banke; ZB, east of Trindelen, about 30 m; TR, FF and TQ near Trindelen; VU, east of Nordre Rønner, 15 m; N.E. of Hirsholmene, 9,5 m (Henn. Petersen). — **Ke:** IL, IP, IQ, ZE¹ Fladen, 21–25 m; ZJ, IR, IS, VZ, Groves Flak, 22,5–26,5 m; Groves Flak (Børgesen); IK, IH, Lille Middelgrund; Store Middelgrund, IA, 16,5 m (!) and 30 m (Børgesen). — **Sa:** KI, south of Hjelm, 13 m; BF, off Sletterhage, 14 m. — **Su:** bM, South of Hveen, 22,5 m.

¹ The above was written long before I received V. SCHIFFNER's Studien über Algen des adriatischen Meeres (Wiss. Meeresuntersuch. N. F. 11. Bd. Abt. Helgoland, Heft 2, 1916). The author describes here (l. c. p. 148) a species named *Cruoriella Dubyi*, which he supposes is identical with the Atlantic species of the same name. This supposition, however, seems to be doubtful, the Adriatic plants apparently differing, in the structure of the frond and of the nemathecia as well. Thus, the frond is said to be rarely more than 6 cells thick; nothing is said as to the complex structure of older fronds described above; and the rhizoids seem to be much more numerous. Further, the paraphyses are said to be attenuated upwards. The author says, p. 148, that the species has been wrongly referred by DE TONI to *Cruoriella*, but p. 501 he approves that SCHMITZ has made the same determination.

Rhododermis Crouan.

Crouan in J. Agardh, Sp. Vol. II, pars 2, 1852, p. 504.

1. *Rhododermis elegans* Crouan.

Crouan in J. Agardh, Sp. Vol. II, pars 2, p. 505. Crouan, Florule de Finistère, 1867, p. 148, pl. 19, fig. 130, Batters, Mar. Alg. Berw., 1889, p. 91, pl. XI fig. 1 (forma *polystromatica* Batters). Kolderup Rosenvinge, Deux. mém., 1898, p. 18, id., Mar. Alg. N. E. Greenl. 1910, p. 104.

This small arctic and north-atlantic species has been collected in several places in the Danish waters. It forms small, thin crusts of a lilac-rose colour with an irregular outline, the diameter of which scarcely exceeds 5 mm. It resembles in many respects *Rh. parasitica* of which KUCKUCK has given an exhaustive description and splendid figures (Beitr. z. Kenntn. d. Meeresalg. 1. Wissensch. Meeresunters. N. F. II, Heft 1. 1897). According to BATTERS, one of the principal differences is that the cells of the frond in *Rh. elegans* are broader than long, while in *Rh. parasitica* they are longer than broad. This difference is in reality general though not absolute, as may be judged from the figures of KUCKUCK and from the fact that cells may be found in *Rh. elegans*, which are at least as high as broad. *Rh. parasitica* differs further by its greater diameter, greater thickness and darker colour. A difference exists also in the structure of the border of the frond, this consisting in *Rh. parasitica* of distinct filaments (KUCKUCK, l. c. p. 7, Taf. VIII fig. 10) while it is continuous in *Rh. elegans* (fig. 118 A).

The basal layer consists of radiating cell-rows, the cells of which are more or less lengthened in a radial direction. In the marginal part of the frond the cell-rows are frequently flabellately radiating towards the irregularly lobed border, here and there showing lateral ramifications (fig. 118 A). The cells are usually $5.5-7\ \mu$ broad, $1\frac{1}{2}$ to 3 times as long as broad. In the basal layer lateral fusions between cells belonging to different cell-rows frequently occur, the cells corresponding through a broad open canal. Such fusions may occur at the very margin of the frond. More than two cells may sometimes fuse together (fig. 118 A, B).

The crust is at first monostromatic, and a rather broad monostromatic marginal part may often be found. The inner part of the frond was always found to be from 2 to at least 5 cells thick. I have never found it distromatic in a greater extent, and I must therefore suppose that it is only accidentally that CROUAN has attributed a distromatic frond to this species, and that there is no reason to maintain the var. *polystromatica* Batters. The cells contain several chromatophores as in *R. parasitica*. In the upper part of the crust the cells are $8-11\ \mu$ broad. In several specimens I found, projecting from the surface, scattered hyaline hairs (fig. 118 C). Their number varied; they were placed between the paraphyses or in the sterile parts of the crust.

The sori form irregular spots on the surface of the frond; they consist of feebly curved paraphyses, usually 4- or 5-celled, $40-50\ \mu$ long, at the base $5-9\ \mu$ broad, and between them the sporangia, which are terminal on the vertical filaments of the crust, the upper cell of which has often the character of an upward slightly

broader stalk-cell. In some specimens from the Little Belt (Middelfart) the paraphyses were but few in number, in some cases almost wanting; the plant had then a certain resemblance with *Rhododiscus pulcherrimus*.

The sporangia are first divided by a transverse wall; the vertical walls occur at a later moment, for which reason sori containing only bipartite and undivided sporangia are not infrequently met with (comp. KUCKUCK l. c. p. 7 and BATTERS l. c. pl. XI fig. 1a). The ripe sporangia are usually $24\text{--}33\ \mu$ long, $16\text{--}20(24)\ \mu$ broad.

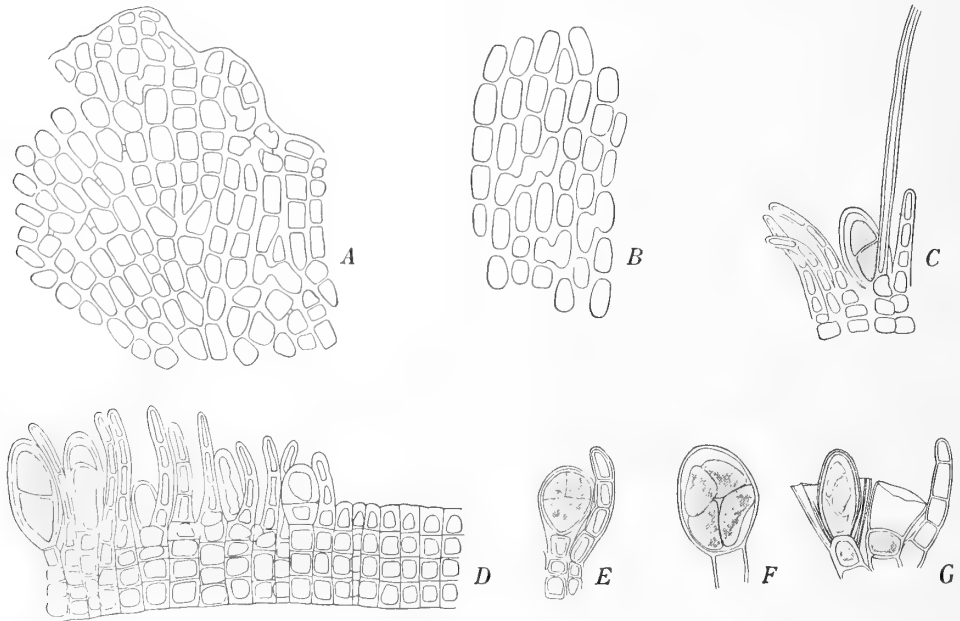


Fig. 118.

Rhododermis elegans. A, marginal part of frond seen from above. B, basal layer of fructifying frond seen from below. C, vertical section of fertile part of frond with paraphyses, a bipartite sporangium and a hyaline hair. D, vertical section of frond with sorus; sporangia bipartite. E, almost globular ripe sporangium from Hornenæs. F, ripe sporangium. G, regeneration of sporangium. 385:1.

The greatest sporangium was found in a specimen from Refsnæs; it measured $33\ \mu$ in length and $24\ \mu$ in breadth. In the southernmost place in the Danish waters (at Hornenæs in the Little Belt) I found almost globular sporangia, $20\text{--}21\ \mu$ long, $18\ \mu$ broad (fig. 118 E). After evacuation a new sporangium may be produced from the stalk-cell within the empty sporangium wall (fig. 118 G).

Sexual organs were not met with. Antheridia are only known in specimens from North-East Greenland (K. Rosenvinge 1910).

As to the time of fructification only incomplete information can be given. In winter (October to February) the species has not been met with, but it must be supposed from observations from the coasts of England and of Greenland, that it will be found fructifying in winter with us, and this supposition is in accordance

with the fact that it has been found with ripe sporangia in March (Lille Belt) and with empty sporangia in April (Limfjord, Samsø waters). On the other hand it has also been found with ripe sporangia in June, July and September, and it seems thus that it may produce ripe sporangia at all seasons.

The species occurs on stones (flint, limestone, granite), shells and carapaces of animals (*Mytilus*, *Serpula*, *Hyas*) and Algæ (*Polysiphonia elongata*, *Chondrus crispus*, hapters of *Laminaria digitata*), in 5,5—19 meters depth.

Localities. **Sk**: YN², S.E. of Bragerne, 10,5 m. — **Lf**: XX in Nissum Bredning, 5,5 m. — **Ku**: TG, north of Læsø, 9,5 m. — **Ke**: VY, Fladen, 18 m. — **Ks**: OP, Lysegrund, 6 m. — **Sa**: Northside of Refsnæs, 19 m. — **Lb**: NV and XQ, near Middelfart, 15—19 m; CC, south side of Hornenæs, 7,5 m.

2. *Rhododermis Georgii* (Batters) Collins.

F. S. Collins in Phycotheca Bor. Amer. No 1299; id., Notes on Algae, III, Rhodora, August 1906, p. 160. *Rhodophysemia Georgii* Batters, New or critical Brit. mar. Algæ. Journ. of Botany, Vol. 38, 1900, p. 377. Kylin, Algenfl. schwed. Westk., 1907, p. 194—196, fig. 41.

Rhododermis Van Heurckii Heydrich, Über Rhododermis Crouan, Beihefte z. Botan. Centralblatt, Bd. 14, 1903, p. 243, Taf. 17.

Strange to say this characteristic little species was first described in 1900, though it has later proved to be widely distributed. It has also been recorded in several places in the Danish waters, always growing, as elsewhere, on *Zostera*-leaves, but it has further been found growing on uncovered roots of *Zostera*.

The plant begins as a thin monostromatic crust much resembling that of *Rhododermis elegans*, and with the same marginal growth. The marginal part is usually continuous with an irregularly undulating outline, and consisting of radiating filaments which are 4—6 μ broad; more rarely the ends of the filaments are free, not laterally connate. Lateral fusions between cells of these cell-rows not unfrequently occur (fig. 119 A). The crust is early divided by horizontal divisions, which advance from the centre towards the periphery, with the result that the crust usually becomes polystromatic to the margin. The radial growth has meanwhile ceased, so that the diameter of the crust rarely exceeds 300 μ .

As shown by HEYDRICH, COLLINS and KYLIN, the species occurs in two forms, a disc-shaped and a globose or pear-shaped or irregularly lobed. In the disc-shaped form, the frond is usually 4 to 5, at most 7 cells thick, when fully developed and fructiferous. The cells of the erect cell-rows are 4—6 μ thick. As shown by HEYDRICH and KYLIN, some of the superficial cells may produce long, vigorous hyaline hairs of the usual type in the Florideæ; they are 5—7 μ thick near the base, and contain a nucleus near the top. The cells of the frond contain a nucleus and several chromatophores.

In the disc-shaped specimens the sorus often originates shortly after the formation of the first horizontal walls. The upper cell produced by these divisions in the central part of the frond develops then in a paraphyse or in a sporangium with its stalk cell, and there is only one layer of vegetative cells under the sorus. When the surrounding cells now continue growing in a vertical direction and dividing

by horizontal walls, the sorus will finally be placed in a groove in the frond (fig. 119 C, comp. HEYDRICH l. c. Fig. 3). When rising later it takes a more superficial position.

The other specimens arise from disc-shaped ones by very strong enlargement of the under cells of the frond with the exception of the peripheral ones. The figures of BATTERS and HEYDRICH show a great number of large hyaline cells in the interior of the frond, suggesting that the erect cell-rows from which they arose consisted of about 10 cells. Such figures represent, according to my observations,

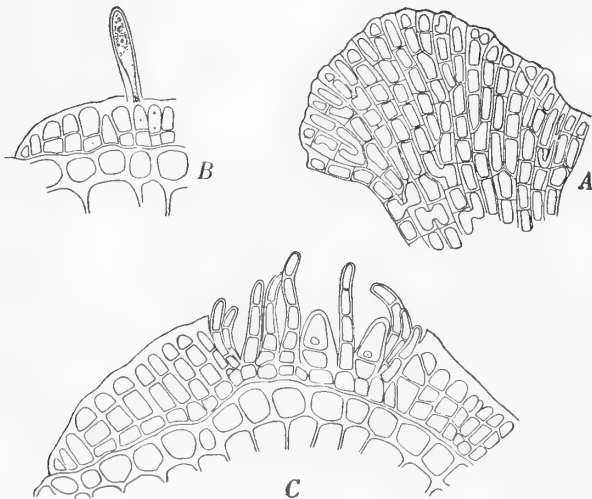


Fig. 119.

Rhododermis Georgii. A, basal layer seen from below, showing the border and lateral fusions. B, marginal part of frond in vertical section, showing a young hair. C, vertical section of disc-shaped frond showing a sorus sunk in a groove. 350:1.

eccentric sections in which a greater number of the outward bent cell-rows have been intersected. According to KYLIN, the cells of the basal layer remain for a long time unchanged, and differ from the cells of the inner tissue through their small size and rich contents. "Schliesslich tritt indessen auch eine Vergrösserung in den Zellen der Basalscheibe ein, indem sie sich zwischen die vergrösserten Basalzellen der verticalen Zellfäden einkeilen." This latter assertion is not in accordance with my observations. In specimens attaining only a smaller height, being only cushion-shaped, the cells of the basal layer remain often unchanged, but in typical specimens of the inflated form they are enlarged at an

early period, and there seems to be ordinarily no question of protruding of these cells between those of the second layer. But the cells increasing not only in length but also in breadth, there is no room for all the cells of the basal layer when enlarging their volume, and a number of them must therefore remain unchanged in size. Connected with the growth of the inner cells is the enlargement of the surface of the frond which makes its appearance in the lateral branching of the cell-rows in the periphery of the frond (fig. 120 C). — In the large vesicular cells a number of small chromatophores are easily visible; in some cases these cells were poor in cell-contents, in others they contained small starch grains.

The simultaneous occurrence of the two forms of the species on the same leaf of *Zostera* is very curious. As a rule, the specimens growing on the faces of the leaves are disc-shaped or low cushion-shaped, while those placed on the margins are inflated. Cushion-shaped specimens may, however, be found on the margins and inflated on the faces, thus the two forms of specimens may occur side by side apparently under equal external conditions; this may perhaps be caused by a different

moment of development. The possibility that there might be two distinct forms is quite precluded by the fact that transitional forms are everywhere met with, and by their accordance in all other respects. Specimens are sometimes found which are partly cushion-shaped, partly inflated and bearing sori in both parts of the frond. It cannot be doubted that the inflated specimens arise under certain conditions which are usually only realised on the margins of the *Zostera*-leaves. It

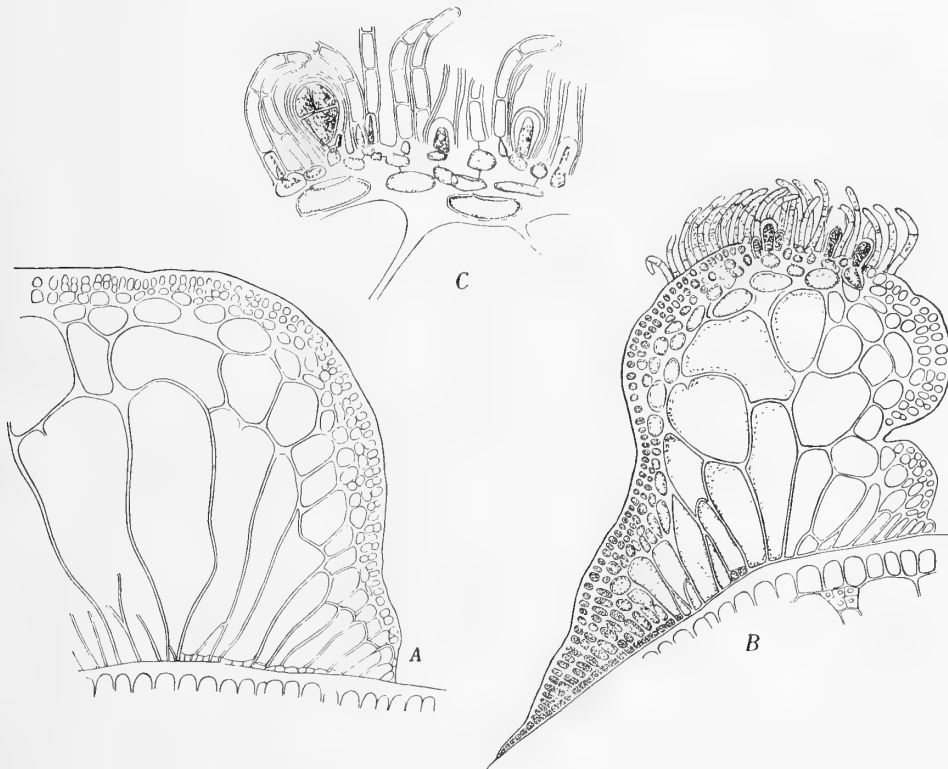


Fig. 120.

Rhododermis Georgii, vertical sections of the inflated form. *A*, sterile plant. *B*, plant with sorus with unripe sporangia. *C*, part of sorus with ripe and emptied sporangia, the latter becoming filled with new sporangia from the stalk-cells. *A*, *B* 200 : 1; *C* 350 : 1.

might be supposed that the *causa efficiens* must be sought in the movements of the water which are much greater at the margins than on the faces of the undulating leaves. It must be left to experimental studies to decide this and to determine whether it is the friction against the water, or the better conditions for nutrition caused by the stronger movements which induce the increased growth of the inner cells of the frond.

The sorus occupies the central part of the frond. Usually there is only one, but sometimes two (or more?) are met with, which perhaps fuse together. As mentioned above, the sorus may sometimes be sunk in a groove. The paraphyses are

curved towards the centre of the sorus; they are 3—5-celled, 6μ broad at the base, upwards a little thinner. The sporangia are born of a stalk cell as in the other species; they are $26\text{--}32\mu$ long, $21\text{--}24\mu$ broad. After the evacuation, a new sporangial cell is cut off from the stalk cell within the empty sporangial wall.

I agree with HEYDRICH and COLLINS in retaining the species in the genus *Rhododermis*. When occurring in its disc-shaped form it resembles *R. elegans* so much that it differs only in the dimensions of the cells of the frond, and there but slightly.

The species grows on the leaves of *Zostera* produced in the foregoing year, but also in shed leaves. It has been met with in the months of April to August, in all these months in disc-shaped and inflated specimens and with sori. In April the sporangia were yet undivided; in May and June unripe and ripe sporangia were met with, in July and August ripe sporangia were found, but also emptied and regenerated ones. The species has also elsewhere been found with sporangia in spring and summer.

Localities. **Lf:** Repeatedly at Nykøbing (!, C. H. Ostenfeld). — **Ku:** In several places at Hirschholmene (!, Ostenfeld, Henn. Petersen); Frederikshavn, Busserev, and between Borrebjergs Rev and Maren's Rev; ZL, S.E. of Nordre Rønner, 6,5 m and 11 m. — **Sa:** Off Risskov at Aarhus.

Fam. 8. Hildenbrandiaceæ.

The family of the Hildenbrandiaceæ, established long since (Comp. RABENHORST, Fl. eur. Alg. III, 1868, p. 408) and still maintained by SCHMITZ in 1882 (Hauck, Meeresalg., p. 37), was later abandoned by this author as the presumed cystocarpia of the genus *Hildenbrandia* had proved to be conceptacles of tetrasporangia, and he therefore ranged this genus under *genera incertæ sedis* in 1889 (Flora, p. 22). In 1897 SCHMITZ and HAUPTFLEISCH range it as a dubious *Corallinaceæ*. On the other hand DE TONI places it under the *Squamariaceæ* in a subfam. *Hildenbrandtieæ* (Sylloge Alg. Vol. IV, sect. IV 1905, p. 1713). I think it better to consider the genus as a representative of a particular family intermediary between the *Squamariaceæ* and the *Corallinaceæ*. Although the sexual reproduction is unknown, the family is sufficiently characterized by the want of incrustation with lime of the frond, by the presence of immersed conceptacles of sporangia, and by the oblique divisions of the sporangia. The conceptacles resemble those of the *Corallinaceæ* but develop in another way, as will be mentioned below. Oblique divisions of the sporangia do not occur in the *Corallinaceæ*, but are characteristic of several *Squamariaceæ*.

Hildenbrandia Nardo.

1. *Hildenbrandia prototypus* Nardo.

Nardo, De novo genere Algarum cui nomen est Hildbrandtia prototypus. Oken's Isis 1843, p. 675; Hauck, Meeresalg. p. 38.

Zonaria deusta Lyngbye, Hydr., 1819, p. 19 ex parte; cfr. notula.

Erythroclathrus pellitus Liebman in Flora Danica, tab. 2317, fig. 2, 1840 (sterile).

Hildenbrandtia rosea Kützing, Phycol. generalis, 1843, p. 384; J. Agardh, Spec., II, pars 2, 1852, p. 495.

Hildenbrandtia sanguinea Kützing, Phycol. generalis, 1843, p. 384, tab. 78, V.

Hildenbrandia Nardi Zanardini, Synops. Alg. in mar. Adriat., p. 238; J. Agardh, Spec. II, p. 494.

When young, the crusts are nearly orbicular, or with a more or less lobed margin. A number of such young crusts frequently fuse together into a large crust, leaving no traces of the limits between the particular crusts. On the other hand, older crusts may, when meeting, be separated by a very distinct limiting line.

The margin is composed of radiating filaments, the ultimate cells of which are long and almost colourless, frequently swollen at the end. Not only the outermost cell, but also the second cell from the border may be several times as long as broad, longer than the next inward following cells of the basal layer, from which it must be concluded that intercalary divisions may occur. Now and then the number of the cell-rows is increased by ramification. The fig. 121 A suggests that the cell-rows may branch by dichotomy; but a closer examination showed that their ramification is really lateral (fig. 121 B. The crust represented in this figure showed numerous lateral branches, some of which penetrated between and under the primary filaments, in the latter case causing irregularities in the structure of the basal layer. In other cases this layer showed a very regular structure; it is densely appressed to the substratum, without rhizoids.

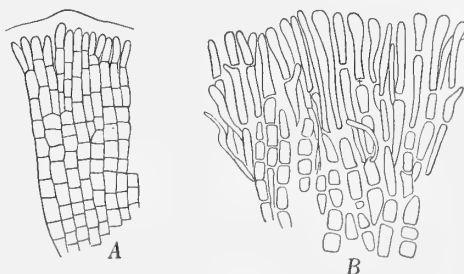


Fig. 121.

Hildenbrandia prototypus, borders of young fronds, seen from the under face. A 350:1. B, showing the lateral ramification and some branches growing under the primary filaments. 560:1.

Horizontal divisions occur at a small distance from the margin. The adult frond is composed of regular vertical rows of nearly cubical cells, which are 4 to 6,5 μ broad. The cell-walls are firm, not swelling at the death of the cells. There is a single calotte-shaped chromatophore situated in the upper part of the cell (fig. 123 C).

The tetrasporangia occur in immersed conceptacles, which often occupy the whole crust except the marginal part and are uniformly spread over it, but may also be arranged in groups. In a fully developed state, the nemathecium are nearly globular or a little depressed, about 100 μ in diameter. The sporangia are situated on the bottom and the sides, and even on the under side of the peripheral part of the roof, the thickness of which diminishes towards the aperture. The conceptacle is not prominent; on the contrary, the surface is often a little sunk towards the aperture.

The conceptacles arise from a small group of superficial cells which produce tetrasporangia, while the contiguous cells remain vegetative and continue dividing by horizontal walls, with the result that the sporangia are placed in a low cavity.

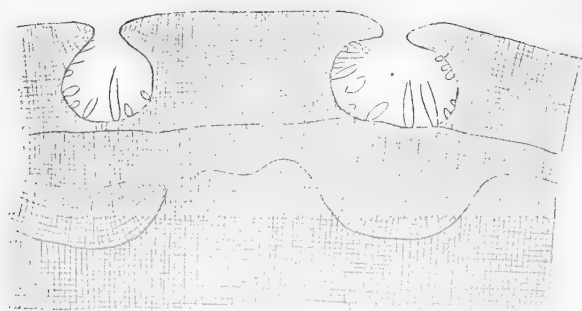


Fig. 122.

Hildenbrandia prototypus, vertical section of old crust showing two conceptacles and limiting lines between the productions of three years. 195:1.

usually apparently a year (or more ?), while the crust grows gradually in thickness. When the sporangia have been emptied, new ones are produced on the same place from the cells forming the bottom of the cavity, within the emptied sporangial walls or between them, and at the same time the formation of sporangia extends at the sides and upwards on the lateral walls of the cavity, the cells of the vertical cell-rows limiting the cavity at the sides producing sporangia directed obliquely or horizontally towards the centre of the cavity, which gradually takes a nearly orbicular outline. The sporangia-producing cells divide into a small stalk-cell and a greater outer cell, the sporangium. The stalk-cells of the lateral sporangia seem usually to decay, and the replacing sporangia must therefore be produced by the cells of cell-rows situated within the stalk-cells. In such a manner the conceptacle increases in transversal outline, new vertical cell-rows being gradually engaged in the production of sporangia. The parts of the cell-rows which are active in this manner are consumed by this production, and the continuity between the upper part forming the roof of the conceptacle and the under part is thus abolished. The upper part of these cell-rows therefore finally decays, at least in those situated nearest the aperture, where the regular arrangement of the cells is disturbed; the cell-walls swell, and the contents become discoloured and degenerate (fig. 125 A). In the peripheral part of the roof, the undermost cells of the interrupted vertical cell-rows often undergo a growth in a transversal direction, in consequence of which the cell-rows become bent inward below (fig. 122). The above

In specimens collected in June I found such cavities about 6 cells in diameter and not so deep but that the sporangia reached the border of the aperture (fig. 123 A). The sporangia in these young conceptacles are of different age. Besides fully developed or two-parted sporangia young ones are found, but also aborted sporangia occur, having sometimes the character of paraphyses (fig. 123 A, B). The production of sporangia continues a very long time,

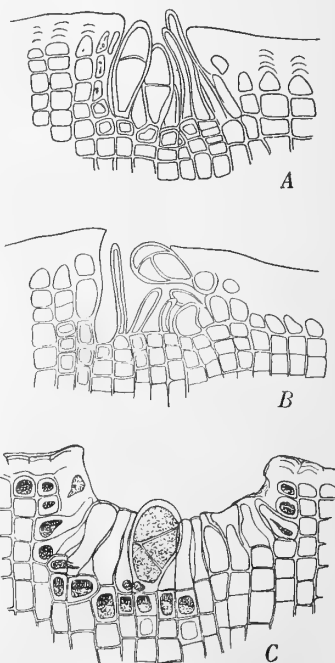


Fig. 123.

Hildenbrandia prototypus, vertical sections of young conceptacles. A and B from specimen collected in June (near Refsnæs), C, from spec. collected in January (Store Belt). 560:1.

described development of the conceptacles has evidently been known to SCHMITZ, as can be seen from the diagnosis of the genus *Hildenbrandia* in SCHMITZ and HAUPT-FLEISCH *Corallinaceæ* in ENGLER u. Prantl, Nat. Pflanzenfam. I,³, p. 544. It is here said that the conceptacles are "anfangs sehr klein, unter allmählich fortschreitendem Verbrauch des nächst angrenzenden Gewebes allmählich an Grösse zunehmen", and that they frequently fuse laterally together. The development is designed as "lysigen" though it is not lysigenous in the usual significance of the word.

The sporangia are somewhat variable in shape and dimensions; they are now ovoid or obovate, e. gr. $21\ \mu$ long, $14\ \mu$ broad, now long, nearly cylindric, e. gr. $30\ \mu$ long, $9.5\ \mu$ broad. The length varies between (16—)21 and $30\ \mu$, the breadth between 9 and 12 ($14\ \mu$). No relation between the dimensions of the sporangia and the locality has been found. The dividing walls are always oblique. The first wall is much inclined to one side, the two following to the opposite side and often parallel to each other. But the first wall is often broken where it meets the following walls, in such a manner that the succession of the walls is not always easily discernible. The upper part of the first wall is often bent downwards so that it goes in continuation of the upper secondary wall, and the sporangium thus presents the appearance of having been divided first

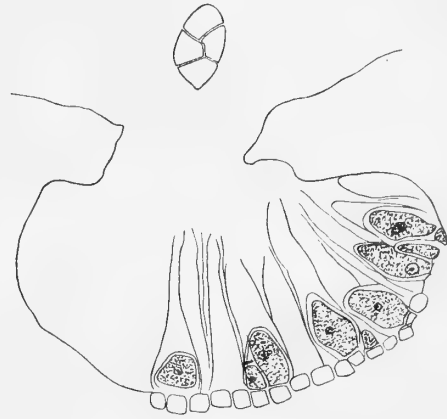


Fig. 124.

Hildenbrandia prototypus. Vertical section of conceptacle with undivided and empty sporangia. Above a ripe sporangium. 560:1.

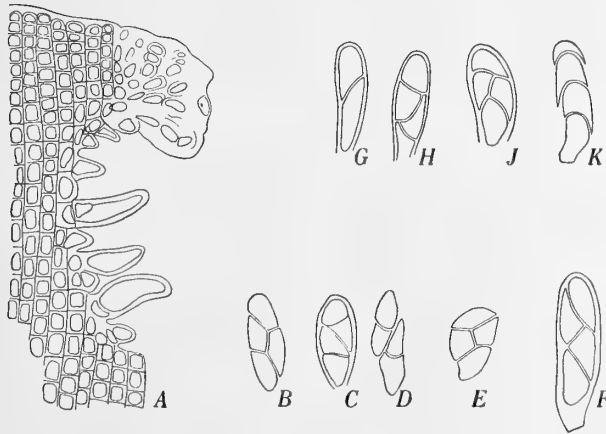


Fig. 125.

Hildenbrandia prototypus. A, left side of conceptacle in vertical section. B—K, ripe sporangia. A—F from Karrebæksfjord, G—K, from Guldborg. 560:1.

into three by two parallel walls and afterwards by a wall dividing the middlemost cell into two (fig. 125 J, B, E, F). The secondary walls nearly always intersect the primary one, but usually near its border; this is true particularly of the undermost wall, which may also meet it at the very border or even intersect the outer wall under the border (fig. 125 C). An extreme case is shown in fig. 125 K where the sporangium has the appearance of having been divided by nearly parallel walls; but on regarding only the insertions and not the curvatures of the walls, it

will be seen that the middlemost (primary) wall is inclined to the left, the two others to the right; the walls, however, do not intersect, in accordance with the unusually narrow shape of the sporangium.

After the evacuation of the tetraspores, the sporangial walls are kept for a long time; they swell and fill the conceptacle. They have been considered as paraphyses by KÜTZING and others, but such organs do not occur in the adult conceptacles (comp. SCHMITZ and HAUPTFLEISCH l. c.). Small *Sarcina*-like bacteria sometimes form strings between the empty sporangial walls.

Conceptacles are met with at all seasons, and ripe sporangia have been found in all the months of the year, most frequently, however, in summer. As a rule empty, ripe and unripe sporangia are found simultaneously, from which it must be concluded that the formation of sporangia continues during the whole year, in the winter only with diminished activity. At what moment the development of the conceptacles begins I cannot say with certainty as I have seen but a small number of young stages. The youngest of the observed stages (fig. 123 A, B) were met with in June, which might suggest that the development of the conceptacles begins in spring, when the growth of the crust must be supposed to be active.

In older crusts the periodicity of the growth is marked by distinct limiting lines between the layers of the successive years. The upper line in fig. 121 probably represents the surface of the frond at the end of the foregoing season, but the lower, more irregular line does not represent an old surface; the deepenings are the bottoms of emptied conceptacles, and the higher parts between them represent the limit of the crust after disorganisation of its upper parts. It really frequently happens that the outer cell-layers die in winter over a greater or lesser part of the crust, and the faculty of growth is then often restricted to limited portions of the frond, which then become higher, and provided with conceptacles, while the other parts are low and sterile.

The species is widely spread in the Danish waters, particularly in shallow water, also over the low-water mark, and in sheltered places, where it is often a characteristic element of the vegetation, covering the stones with a red crust in company with *Ralfsia* etc., frequently under *Fucus*. But it is also common in deeper water, even in the greatest depths where vegetation has been met with, e. g. in the North Sea at 31 meters depth, in the Little Belt at 26,4 m and near Bornholm at 38 m, but it seems to be less abundant at greater depths. It has repeatedly been met with in a fructiferous state at about 19 meters depth, at Bornholm even at 29 m. In very insolated localities in shallow water it takes a yellowish colour during summer.

Localities. **Ns**: aF, off Thyborøn, 31 meters, small sterile specimens; groin at Thyborøn. — **Sk**: YU, Roshage, Hanstholm, 2 m, small sterile spec.; washed ashore near Bulbjerg, sterile; Hirshals, on stones adhering to the hapters of Laminariæ washed ashore after storm, sterile. — **Lf**: Rønne near Lemvig, 3 m, MA, off Jestrup, 5 m; Oddesund, stone slope, fr.; Nykøbing and elsewhere in Sallingsund; aT¹, Draaby Vig; Livø Bredning (C. H. Ostenfeld); west side of Feggeklit. — **Ku**: Herthas Flak, 21—25 m, ster.; Hirsholmene; Deget; Busserev; Frederikshavn; Nordre Rønne. — **Km**: Mariager Fjord, at Hobro;

ND, off Fornæs, 11,5—13 m. — **Ks**: HR south of Hesselø; shore at Gilleleje; D, off the entrance to Isefjord; Ourø, near Roskilde and Boserup in Isefjord. — **Sa**: FS, Vejrø Sund; PG, west of Hatter Rev; north end of Besser Rev; north-side of Revsnæs (Ostenfeld); shore by Koldby Kaas; Bolsaxen; Hinds-holm (Lyngbye); NZ, off Tørræsø; Odense Fjord, inner side of Enebærødden (!) and shore at Hofmans-gave (Car. Rosenberg); Juelsminde. — **Lb**: OB, off Stavrhoved; Snoghøj, Middelfart, Fænø a. o. places from 0 to 19 meters; CE, south of Helnæs, 26 meters. — **Sf**: UV, north of Ærø; Birkholm. — **Sb**: Refsnæs; Romsø Sund (Ostenfeld); NU, off Strandskoven near Bogense; stone reef at Korsør; GP, Hal-skov Rev; near Sprogø, 10—15 m (Ostenfeld); AC, off Knudshoved, 17 m; DN, Vengeance Grund; Ny-borg Fjord, shallow water; near Vresen, 23—24 m (Ostenfeld). UT and US¹ in Langelandsbelt, about 19 m. — **Sm**: Karrebæksfjord off Skraverup (Warming); Guldborg (C. Christensen); HF, west of Farø. — **Su**: bM south of Hveen, 22,5 m; Hvidøre; off Charlottenlund; south end of Middelgrund; Trekroner (Rützou); QC, QD, Saltholms Flak; PR¹ off Dragør, 4 m. — **Bw**: DV, south of Marstal; LC, near Gul-stav, 11 m; UP off Kramnisse Gab; UM, Kadetrenden. — **Bm**: HG, Præstebjerg Rev, 7 m; QS, N. of Møens Klint 21 m; at Møens Klint; VD, Bøgestrømmen; QQ off Rødvig; RG, N.W. of Falsterbo; QN, off Køge Søhuse 6,5 m. — **Bb**: SF, Adler Grund; SH, Rønne Banke; Off Rønne, 13 and 38 m (Børgesen, !), reef at Rønne; Davids Banke, 29 m; off Gudhjem; YA, east of Dueodde lighthouse 38 m; Christiansø.

2. *Hildenbrandia Crouani* (J. Agardh.)

J. Agardh, Spec. G. O. II, 1852, p. 495, III, 1876, p. 379; Batters in Journal of Botany 1897, p. 438.
Hildenbrandtia rosea Crouan, Florule de Finistère, 1867, p. 148, pl. 19 fig. 126, non Kützinger.

In the Little Belt I found by dredging in depths of 15 to 19 meters a stone covered with crusts of a *Hildenbrandia* which in habit scarcely differs from *H. prototypus*. It forms pretty blood-red crusts with similar conceptacles. In the structure of the frond and the shape and dimensions of the conceptacles it agrees also with the named species. The cells are 6—7 μ broad and contain a calotte-shaped chromatophore, the conceptacles are up to 100 μ in transverse diameter. On the other hand, it differs decidedly by its cylindric sporangia divided by parallel oblique walls, in which respect it agrees with *Hildenbrandia Crouani* J. Agardh.

This species was first described on the basis of specimens sent from CROUAN, but, as shown by AGARDH and BATTERS, the brothers CROUAN have confounded it both with *H. rosea* Kütz. (*H. prototypus*) and with *Hæmatocelis rubens* J. AGARDH (BATTERS l. c. p. 438). I have had an opportunity of comparing my specimens with those in AGARDH's herbarium sent from CROUAN (herb. AGARDH no 27613 "roches de l'anse du Corsens, environs de Brest") upon which his description is founded, and I have found them fully agreeing. I found also accordance with microscopical preparations from BATTERS in AGARDH's Herbarium.

The conceptacles are similar in structure and development to those of *H. prototypus*. The cell-rows in the peripheral part of the roof are much bent inward below, in consequence of the transverse growth of the undermost cells, as sometimes also occurs in *H. prototypus* (comp. p. 204), while the cell-rows in the inner part of the roof decay. The sporangia are produced, as in *H. prototypus*, from the bottom and the sides, and also from the peripheral part of the roof. A little stalk-cell is present; J. AGARDH has already perceived that the sporangia are pedicellate, but he wrongly indicates that the stalk is articulated (Sp. III, p. 379). The spor-

angia were found to be $19\text{--}30\ \mu$ long, $6\text{--}7\ \mu$ broad; the normal length of the fully ripe sporangia is probably nearest the upper limit indicated. The sporangia have thus the same length as those of *H. prototypus*, but are narrower.

Zonate sporangia, divided by transverse walls, were described and figured in *Hildenbrandia rubra* Harvey in Phycol. Brit. pl. 250, 1851; but it is rather probable that this figure really represents *H. prototypus*, as it shows the same shape of the

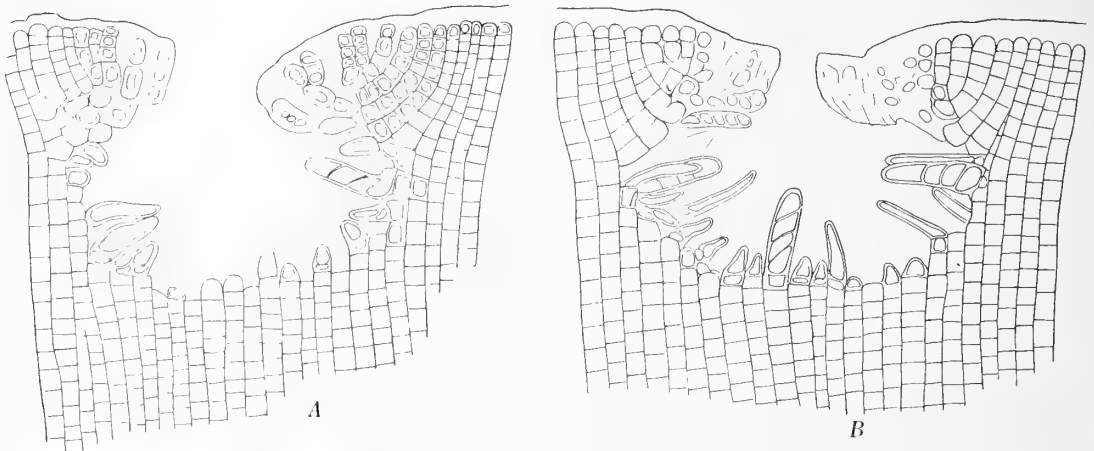


Fig. 126.

Hildenbrandia Crouani. Vertical sections of conceptacles. 560:1.

sporangia as in this species, and the pretended zonate division might then be due to an inexact observation of the irregularly divided sporangia.

Zonate sporangia have further been described in *H. prototypus* var. *kerquelensis* ASKENASY (Forschungsreise S. M. S. Gazelle. Botanik, Berlin 1888 p. 30), the sporangia of which are said to be cylindric and divided by exactly parallel walls in 4 parts. As nothing is said with regard to the direction of the walls it must be presumed that they are transverse. It otherwise differs from *H. Crouani* by its conceptacles being up to $200\ \mu$ high but only half as broad, while those of *H. Crouani* are broader than high.

Locality. Lb: Opposite to Middelfart, 15—19 m, July 1900.

Fam. 9. Corallinaceæ.

J. ARESCHOUG (1852), Corallinæ in J. G. AGARDH, Spec. gen. et ord. Alg. Vol. II pars 2.

M. FOSLIE (1891), Contribution to Knowledge of the Marine Algæ of Norway. II. Tromsø Museums Aarshefter. 14.

— (1895), The Norwegian Forms of Lithothamnion. D. kgl. norske Videnskabers Selsk. Skrifter. 1894. Trondhjem.

— (1898 I), Systematical Survey of the Lithothamnia.

— (1898 II), List of Species of the Lithothamnia. Ibid. 1898, No 3.

- M. FOSLIE (1900), Revised systematical Survey of the Melobesieae. Ibid. 1900. No 5.
 — (1905), Remarks on Northern Lithothamnia. Ibid. 1905. No 3. (Issued 1906).
 — (1909), Algologiske Notiser. VI. Ibid. 1909, No 2.
 F. HAUCK, Die Meeresalgen Deutschlands und Oesterreichs. Leipzig 1885 (1882—1885).
 F. HEYDRICH (1900), Die Lithothamnen von Helgoland. Wissensch. Meeresunters. N. F. IV. Band. Abt. Helgoland. Kiel und Leipzig.
 MME PAUL LEMOINE (1911), Structure anatomique des Mélobésiées. Application à la classification. Annales de l'Institut Océanographique. Tome II fasc. 2.
 F. MINDER, Die Fruchtentwicklung von Choreonema Thureti. Freiburg i. Br. (s. a.)
 R. PILGER (1908), Ein Beitrag zur Kenntnis der Corallinaceae. Engler, Botan. Jahrbücher. 41. Bd.
 S. ROSANOFF (1866), Recherches anatomiques sur les Mélobésiées. Mémoires de la soc. sc. nat. Cherbourg.
 FR. SCHMITZ und P. HAUPTFLEISCH (1897), Corallinaceae. Engler u. Prantl, Nat. Pflanzenfam. I. 2. Leipzig.
 SOLMS-LAUBACH (1881), die Corallinalgen des Golfes von Neapel. Leipzig.
 H. F. G. STRÖMFELT (1886), Om algevegetationen vid Islands kuster. Göteborg.
 N. SVEDELIUS (1911), Corallinaceae. Engler u. Prantl, Nat. Pflanzenfam. Nachtr. zu I. Teil, Abt. 2. Leipzig.
 G. THURET (1878), Études phycologiques. Publ. par les soins de M. le dr. E. Bornet. Paris.

When carrying out my systematic investigations in the Danish waters, I arranged with M. FOSLIE, the well-known authority on calcareous algæ, that he should deal with the *Melobesieae*-group of the family of *Corallinaceae*, and forwarded to him accordingly, from time to time, such material as I had collected of these algæ, which he also mentioned in various publications. Unfortunately, M. FOSLIE's energetic work in this field was brought to a close by his unexpected and premature decease in 1909. Since then, I have collected but few calcareous algæ, and nearly all the present specimens from Danish waters have thus been determined by FOSLIE. As we know, this writer repeatedly altered his view concerning the limitation of these difficult species, and his last great work on Northern Melobesieae (Remarks 1905) bears evident witness to his indecision on this point. When, after his demise, I myself took up the task of dealing with this group, I considered it necessary to investigate all species by means of microtome sections, in order to obtain closer knowledge as to the structure of the frond and reproductive organs, being also further instigated hereto by the newly published works of PILGER, MME LEMOINE and MINDER. In many cases, the results attained were disproportionate to the amount of time involved, partly owing to the fact that the great bulk of the material had only been preserved in a dried state, and also because suitable developmental stages of the various sorts of conceptacles were in many cases lacking. With regard to distinction of species, for the *Lithothamnia* I have in the main followed FOSLIE in his valuable work above-mentioned; on the other hand, closer investigation has led me to distinguish several new *Melobesia* species.

With regard to structure and development of the frond and reproductive organs, I may refer to the works above quoted by ROSANOFF, SOLMS, PILGER, MME LEMOINE, MINDER and SVEDELIUS, as also to what is stated below with regard to the various species. It will here suffice to mention certain particular features.

The frond is in all cases composed of branched cell filaments, the cells of which are connected up by pits of the structure characteristic in Florideæ, in the middle of the transverse walls. These pits are however, very thin, and are often

not distinctly visible in the dried material; they are therefore in many cases not shown in the illustrations, or if so, only in small numbers, though as a matter of fact, they are always present, or have at any rate been so. I mention this point, as Mme LEMOINE states that the cells are in some cases connected by open channels, (Struct. p. 35) and that in other instances, neither pits nor channels were found (l. c. p. 37). As illustrations of the latter, the writer in question cites *Lithothamnion læve* and *L. norvegicum*; I can here refer to my figs. 129 and 143, where the pits are shown.

Pits between cells belonging to different filaments are found in the Danish species only within the genus *Lithophyllum*, where the cells in the perithallium form transverse layers, in which they lie at equal height, and are then connected by pits with all the cells in the same layer, with which they are in contact. This has, it is true, been known before, but the importance of the fact as a systematic character has not been sufficiently emphasized. The character in question would in particular seem to afford an excellent means of distinguishing between the genera *Lithophyllum* and *Melobesia*, which otherwise closely resemble each other. Unfortunately, I have not been able to ascertain how these pits arise; they are formed at an early stage, and I must presume that they originate in a similar manner to the secondary pits in the *Rhodomelaceæ* etc., though I have not been able to demonstrate the co-operation of nuclei in the process, probably owing to insufficient fixing and staining of the material.

In all other genera (where, as we have seen, no such transverse pits are found) the cells possess another means of entering into connection with cells in other filaments, viz. by forming an open communication between them, the separating wall being partially dissolved. These fusions, which were first described by ROSANOFF, are of common occurrence in the Danish species of the family which do not belong to the genus *Lithophyllum*¹.

Where the cells lie densely packed and the walls are thin, the fusions make themselves apparent merely by the fact that the longitudinal walls are partially dissolved (*Lith. Lenormandi* fig. 133 D); where the cell walls are thicker, on the other hand, a distinct connecting channel of varying length is seen. These appear both in the hypothallium and in the perithallium, and may very often take place between more than two cells. They are particularly easy to distinguish in the basal layer of *Melobesia* and in the central tissue of the upright, branched *Lithothamnion*. In the latter, they often form characteristically curving partially branched bodies, which may embrace almost all the cells in the central tissue (fig. 139). In the perithallium also, however, of the mentioned *Lithothamnion*, they may be extraordinarily frequent (*Lith. calcareum*, fig. 144, etc.). FR. SCHMITZ, who has investigated these fusions with regard to the behaviour of the nuclei, found in 1880 (Untersuch. über die Zellkerne der Thallophyten. Sitzungsber. der niederrhein. Gesellsch. f. Natur- u.

¹ Of the species mentioned below, they appear to be lacking only in *Choreonema Thureti*, where the vegetation organs are highly reduced (cf. Minder l. c.) and in *M. minutula* (fig. 172).

Heilkunde zu Bonn 1880) that the nuclei, in two fusing cells of *Jania rubens* did not fuse together. I came to a different result on investigating this point in several other species, especially *Corallina officinalis*. In a tetraspore-bearing plant of this species I found the fusions followed by a fusion of the nuclei. The process was studied in the central tissue under a young conceptacle where numerous fusing cells were found, partly in pairs, partly a greater number fusing together. As shown in fig. 127, the two nuclei of a fusing pair of cells are frequently found lying near each other at the place where the two cells have fused together, and there is reason to believe that the nuclei have been active in the realisation of the cell-fusion. In some cases the nuclei were found touching, and finally fused cells were found containing only one nucleus situated at the same place and derived from fusion of the two nuclei (fig. 127 D). These fusional nuclei seem to be

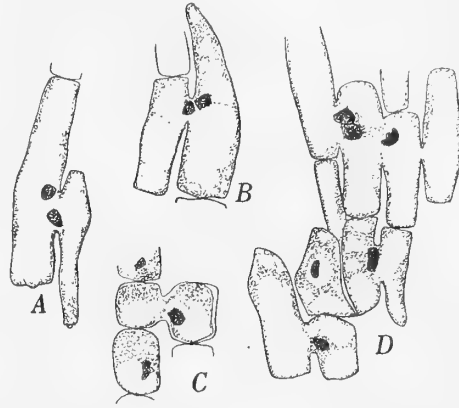


Fig. 127.
Corallina officinalis. Fused cells from a vertical section of a young joint under a young sporangial conceptacle. 730:1.

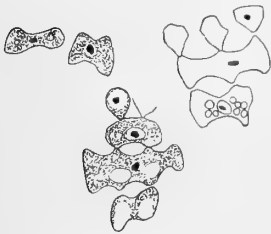


Fig. 128.
Lithothamnion glaciale var. *Granii*. Syncytia produced by fusion of from two to four cells, all showing only one nucleus; at right a cell containing starch grains. 650:1.

able to fuse with other nuclei when fusion takes place between more than two cells. In fig. 127 D is shown a syncytium produced by fusion of four cells and containing at left two nuclei in mutual contact and near the middle a nucleus which must be supposed to have arisen from fusion of the nuclei of the two cells at right. This nucleus has approached the middlemost opening, where it would perhaps later on have fused with the other fusional nucleus. Syncytia arising from fusion of four cells but containing only one nucleus, undoubtedly produced by fusion of the nuclei of the cells, I have observed in *Lithothamnion glaciale* var. *Granii* (fig. 128). Also in *Melobesia* uninucleated syncytia produced by fusion of two cells were observed. It must therefore be supposed that fusion of nuclei generally occur in the fusing cells.

That SCHMITZ has not observed them may be due to the fact that the process was not so far advanced in the plant investigated by him; it might also be imagined, however, that fusion does not take place in all cases, since multinucleate syncytia are found even in older tissue. It is not unlikely that the nuclei may themselves co-operate in the process of fusion, the nuclei of the two cells placing themselves opposite each other in the two cells and bringing about a dissolution of the cell wall. The reason of their taking up such a position would then be, that a mutual attraction exists between them, in which case it would be natural to suppose that such attraction should continue to exist after the fusing of

the cells, finally resulting in a fusion of the nuclei themselves. If this were so, then the fusion of the nuclei would be of no particular importance in itself, but merely a consequence of the cell-fusion. Such supposed co-operation of the nuclei in effecting the fusion of cells is, however, purely hypothetical; I have not with certainty observed the nuclei immediately prior to commencement of the fusions, and it must be admitted that certain cases where cell fusions took place between four cells (fig. 127 *D*) do not tend to support the theory. Fusion of nuclei in vegetative cells of higher plants has recently been observed in several cases, where cells have, for some reason or other, proved to contain more than one nucleus (cf. for instance Schürhoff, Kernverschmelzungen in der Sprossspitze von *Asparagus officinalis*. Flora, N. F. 8. Bd. 1916, p. 55).

The cells always contain, fusions apart, a single nucleus. The only exception is the female plant of *Corallina officinalis*, where the cells of the central tissue contained from two to four nuclei. The chromatophores are small, disc-shaped; there is often a rather small number in each cell (figs. 130, 143 *E*; comp. Pilger l. c. p. 253).

Starch-grains occur in all the species. They are often very numerous, particularly in the older tissues. Mme LEMOINE distinguishes between single and compound (coalescents) starch grains. According to my observations, this distinction appears to depend exclusively on whether the cells are more or less densely filled with starch grains, in the first case the grains may be applanated on the faces where they meet, as also stated by PILGER (l. c. p. 254), but they are not really connate. In *Lithothamnion glaciale* var. *Granii*, which is said by Mme LEMOINE to possess compound starch grains, I found distinct single grains (fig. 128). The starch-grains frequently contain a small air-bubble in the centre in the preparations from dried specimens (comp. figs. 130 *B*, 143 *F*, 174).

The well known transversal limiting lines which undoubtedly indicate periods of stand-still in the growth occur in all the species of *Lithothamnion*, except those with thin crust, but they are also met with in *Lithophyllum orbiculatum* (fig. 180 *A*), whereas Mme LEMOINE did not find them in any species of this genus (l. c. p. 28). As shown by this author they are very intensely stained by hæmatoxyline; they may pass between the cells, coinciding with the middle-lamella, but more frequently they meet the longitudinal walls of the cells without bending under them (figs. 136, 138, 143, 144, 145). Mme LEMOINE describes further alternating zones with varying power of staining with hæmatoxyline. Such zones, not limited by a blue line, were met with in *Lithophyllum norvegicum* where the ordinary limiting lines were otherwise also present (fig. 143 *B, C*).

In some genera (*Melobesia*, *Lithophyllum*, *Corallina*) unicellular, hyaline hairs occur. They resemble those occurring in numerous other Florideæ (com. L. KOLDERUP ROSENVINGE, Remarks on hyal. unic. hairs; Biolog. Arb. tilegn. E. Warming, 1911, p. 203) but differ, however, in not being limited from the cell producing them by a transversal wall. The hair-producing cells have been long known in the species of *Melobesia*, particularly *M. farinosa*, where they were given the name of heterocysts

by ROSANOFF (1866 p. 70), but as shown by SOLMS (1881, p. 24), they are really hairs or hair-producing cells. They are easily recognizable after the hair has been shed, showing a scar left by the latter; I propose to name them trichocytes or hair-cells.

The sporangia are always divided by one or three transversal walls, dividing the cells into two or four spore-cells. Vertical divisions I have only found as rare exceptions in *Lithothamnion Sonderi* (fig. 137 E, F). The tetrasporic sporangia are first divided by a transversal wall, but the formation of this wall proceeds slowly from the periphery towards the centre, and the formation of the two following walls has frequently begun before that of the first is completed. In *Corallina officinalis* I found that the primary nucleus of the young sporangia divides into four nuclei which arrange themselves in a longitudinal row in the middle of the sporangia, and that these rest for a long time in this stage before the divisions, which take place almost simultaneously (fig. 197). Also in *Epilithon membranaceum* the three divisions are almost simultaneous (fig. 152, comp. otherwise fig. 134). The dividing wall is shown in figs. 131 B and 142.

The number of spores is constant in most of the species, either 4 or 2; but in some species both disporic and tetrasporic sporangia are met with. One of these species is *Lithothamnion læve* which, however, in the Danish waters has only been found with disporic sporangia. The above mentioned fact that the divisions of the tetrasporic sporangia are, at least in several cases observed, almost simultaneous, makes it improbable that the disporic sporangia can here be interpreted as unripe, not fully divided. It is an incontestable fact that some species may, according to circumstances, have tetrasporic or disporic sporangia. This I have also found to be the case in *L. Lenormandi*, in which only tetrasporic sporangia were previously known. In *Melobesia Fosliei* also, and in *M. minutula*, both kinds of sporangia would seem to occur.

In material fixed in Juel's liquid the protoplasm of the tetraspores showed a foamy structure. The central part containing the nucleus was brighter and distinctly marked off from the outer (figs. 132, 142 B and Plate III fig. 1).

The antheridia present considerable differences as to their position and development. In *Lithothamnion Lenormandi* they have a similar position to that previously described in *L. polymorphum*, being produced on the surface of great bushes extending from the periphery towards the centre of the conceptacle (Plate III fig. 2). If this structure is to be found in all the species of the genus, we have here an important generic character. In *Epilithon membranaceum*, referred by some authors to the genus *Lithothamnion*, the antheridia are, as shown by GUIGNARD (Rev. gén. de Bot. I. 1889, p. 182) seriate in short filaments clothing the bottom of the conceptacle, and in the other genera the antheridia (spermatangia) are also placed on the bottom of the conceptacle, being produced as outgrowths from a layer of small cells, but they are not seriate. The antheridia are more or less lengthened, short cylindrical or upwards somewhat thickened and more or less curved. In *Melobesia*

Lejolisii, the spermatia are produced at the end of long sterigmata, as shown by Mrs. WEBER-VAN BOSSE, and the same was found in *Lithophyllum Corallinae*. In the last named species the isolated spermatia found in the conceptacles were seen to contain two nuclei (fig. 189), an interesting fact, as spermatia with two nuclei have formerly only been observed in spermatia fixed to the trichogyne, but not at an earlier term.

Concerning the development of the cystocarp in the Corallinaceæ, diverging statements have been advanced. As I have had no occasion of making thorough researches on this question, I must, in referring to the quoted papers of SOLMS, SCHMITZ u. HAUPTFLEISCH, PILGER and MINDER, content myself with stating some few facts noted in some of the species in question.

The carpogonial filaments are, at least usually, two-celled, being composed of a terminal carpogonium and a cell situated under it, separated from it by a more or less inclined wall; probably an auxiliary cell (fig. 148 C). A hypogynous cell as that described in *Choreonema* by MINDER (l. c. p. 12) was in no case observed. As shown by BORNET and THURET (1878) and SOLMS (1881) a large disciform cell, from the border of which the carpospores are produced, arises after the fertilization in the bottom of the female conceptacle. SOLMS and SCHMITZ were of the opinion that in *Corallina* it arose from fusion of all the auxiliary cells. PILGER showed that in *Lithothamnion Philippii* the two cell-layers situated below the carpogonial branches in fusing together take part in the formation of the disc-cell. On the other hand, MINDER, by a careful study of *Choreonema Thureti*, showed that the disc-cell arises in this plant from the fertilized carpogonium, which increases, becomes lobed and gradually fuses with all the auxiliary cells, the contents of which is absorbed by the disc-cell, which is thus no fusion-cell. The statements of MINDER appear to be so well founded that they cannot be doubted and it must be supposed that similar processes also take place in other *Corallinaceæ*, though with various modifications in the different genera, e. g. combined with other cell-fusions. Having in most cases had only insufficiently preserved material of female conceptacles, I can only state, that the carpospores are in most of the species examined produced at the periphery of the cystocarp, as in *Corallina* and others, but that in *Lithothamnion Lenormandi* and *Lithothamnion polymorphum* they arise also from various points of the bottom of the conceptacle. In these cases a disc cell could not be observed in the dried material and it was impossible to state whether the aberrant position of the carpospores is founded on the fact that the disc-cell is more irregularly lobed or whether it must be otherwise explained. As to HEYDRICH's statement of the development of the carpospores in *Lith. polymorphum*, reference may be made to the mention of this species below.

Lithothamnion Philippi.

Subgenus *Eulithothamnion* Fosl., char. mut.

Conceptacles of sporangia superficial or more or less immersed;
the roof plane or vaulted.

1. *Lithothamnion læve* (Strömf.) Fosl.

FOSLIE in K. Rosenv. Deux. Mém., 1898, p. 14; Rev. Surv., 1898, p. 15; Remarks, 1906, p. 16 and 131; Algol. Notiser V, 1908, p. 6; K. ROSENVINGE, Mar. Alg. N. E. Grønland, 1910, p. 100, fig. 1; Lemoine, Struct., 1911, p. 74, figs. 36 and 37.

Lithophyllum læve Strömfelt, Isl., 1886, p. 21, tab. I fig. 11—12.

Lithothamnion Lenormandi (Aresch.) Rosanoff, f. *læve* (Strömf.) Fosl., Contrib. II., 1891, p. 11.

Lithothamnion tenue K. Rosenvinge, Grønland. Havalg., 1893, p. 778, figs. 4—7 (Alg. mar. Gr. p. 58).

Lithothamnion Strömfeltii Fosl., Norw. Forms, 1895, p. 145.

This species, very common in the Arctic Sea, has been found in two localities in the sea north of Sealand, the most southerly stations known in Europe. The specimens from the Kattegat were mentioned by FOSLIE in 1906 (Remarks p. 131). I have examined the structure of the specimen from the Sound which was preserved in JUEL's liquid. The species is easily distinguished from *L. Lenormandi* by its smooth surface and the large conceptacles.

The thallus in the Danish specimens is thin. The filaments of the hypothallium are, as pointed out by Mme LEMOINE, loosely connected. When seen from the surface, they show here and there transversal fusions. The cells are $21-33\mu$ long, $7.5-9.5\mu$ broad. According to Mme LEMOINE, the undermost cells of the hypothallium form rectangular cells directed towards the substratum, thus constituting "une rangée de rhizoïdes obliques". I have not been able to see anything of this kind in the specimen examined. The filaments of the perithallium are composed of a small number of roundish cells, 7μ thick or a little more, up to 10μ . These dimensions, which I found in specimens from both localities, are in accordance with FOSLIE's statement (Remarks p. 18), while Mme LEMOINE gives the thickness as only $4-5\mu^1$. The

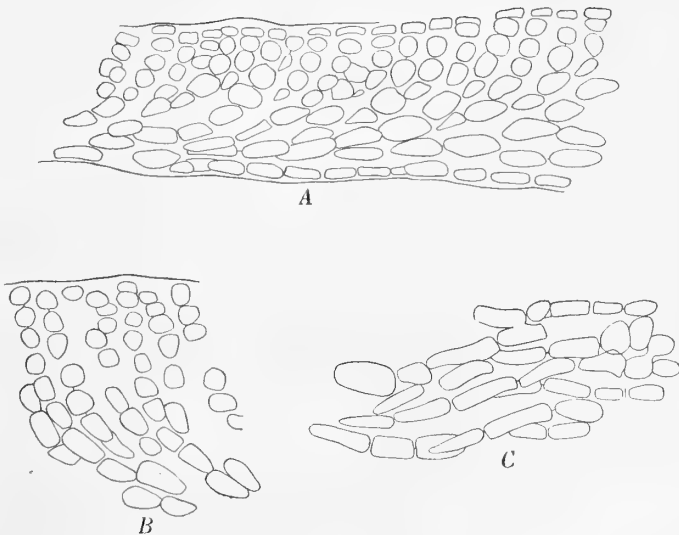


Fig. 129.

Lithothamnion læve. A and B, vertical sections of crust. C, Hypothallium seen from below. From Hellebæk. 350:1

¹ This indication is not in accordance with the figures of Mme LEMOINE, in which the cells are thicker.

cells of the hypothallium and the undermost part of the perithallium often contain a number of distinct starch grains. In the cells of the perithallium a nucleus and a small number of disc-shaped chromatophores could be distinguished. (fig. 130).



Fig. 130.
Lithothamnion læve. A, cells from the perithallium showing chromatophores and nucleus. B, cells from the hypothallium showing starch-grains. 730:1.



Fig. 131.
Lithothamnion læve. A, vertical section of conceptacle of sporangia. B, part of a similar section. 200:1.

Localities. **Ks:** A, S.E. of Hesselø, 28 m on stone and shell. — **Su:** Hellebæk Aug., on *Mytilus Modiola*, Henn. Petersen.

2. *Lithothamnion Lenormandi* (Aresch.) Foslie.

Foslie, Norw. Forms, 1895, p. 150; Heydrich, Lithoth. von Helgoland, 1900, p. 78, Taf. II, fig. 23–25; Foslie, Remarks, 1905, p. 12; Mme Paul Lemoine, Struct. anat., 1911, p. 81¹; Deux. expéd. antarct. franç. 1913, p. 10.
Melobesia Lenormandi Aresch. in J. Agardh. Sp. G. o. II p. 514.

¹ Mme LEMOINE cites the fig. 7 of my paper, "Grønlands Havalger" as representing *Lith. Lenormandi*; however, it does not represent this species but *L. tenue* Rosenv. (= *L. læve* Strömf.).

In the Danish specimens, only conceptacles of sporangia were met with. Their diameter is somewhat smaller than in the Greenland specimens; in the plants from Hesselø it is 500–650 μ , in those from Hellebæk 600–800 μ . The roof consists of narrow filaments of cells which are longer than in the vegetative frond, and connected with numerous transverse fusions, while the cells are only rarely fusing in the perithallium. The sporangia I found always disporic when fully developed, 126–129 μ long, 67–72 μ broad, thus somewhat smaller than in the specimens from Greenland. The species has otherwise been found with two and with four spores in the sporangia. Foslie has (1908, p. 7) given all the localities where it has been found with two-celled sporangia only and those where it has been met with only with four-celled sporangia. Both are found in a number of localities in the arctic regions and at the Norwegian coast as well.

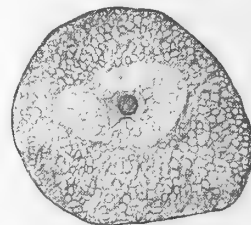


Fig. 132.
Lithothamnion læve.
Tetraspore.
390:1.

Lithophyllum Lenormandi (Aresch.) Rosanoff, Rech. anat. p. 85, pl. V, fig. 16 et 17, pl. VI, fig. 1, 2, 3, 5. (Fig. 5 is said in the text to represent *L. Lenormandi*, while in the explanation of plates it is attributed to *L. lichenoides*). Hauck, Meeresalg. p. 267, Taf. III fig. 4; Strömfelt, Algveg. Isl. kuster, p. 21, tab. I, fig. 9—10.

Lithothamnion squamulosum Foslie, Norw. Forms of Lithoth. p. 155, Tab. 19 fig. 24—26.

Squamolithon Lenormandi (Aresch.) Heydrich, Die Lithoth. von Roscoff. Ber. deut. bot. Ges. 1911, p. 26, Taf. II.

This widely spread species has been met with in almost all the Danish waters. It is particularly characterized by its thin reddish-violet crust with a lobed, whitish border, by its hypothallium composed of densely joined filaments, and at all events in the typical species, by the densely crowded conceptacles.

As pointed out by Mme LEMOINE, the hypothallium is composed of more densely joined filaments than in the other crustaceous species. According to this author, the number of horizontal filaments in a vertical section is usually 7—8; in thicker crusts it may be greater (fig. 133 B), in thinner it may be only 3—4 (fig. 133 A, C). In horizontal sections through the hypothallium transverse fusions are frequently seen

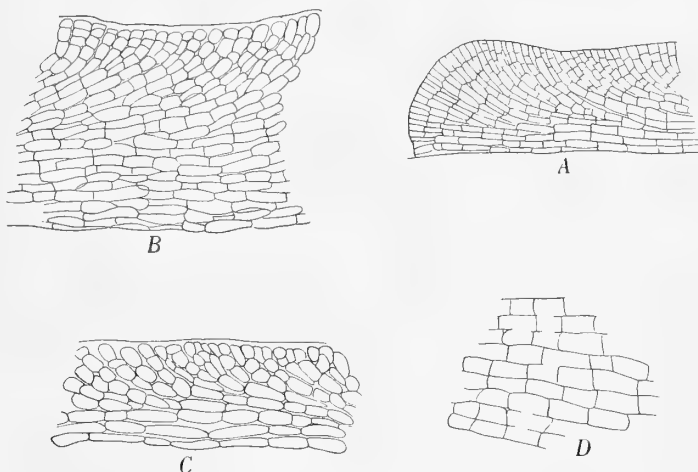


Fig. 133.

Lithothamnion Lenormandi. A, vertical section of border of frond, not decalcified, made by grinding. B and C, vertical sections of thick and thin crusts, made by microtome through decalcified fronds. D, horizontal section of hypothallium showing fusions. A 195:1. B—D 350:1.

(fig. 133 D). Mme LEMOINE states that the filaments of the hypothallium “se relèvent d’une façon très brusque pour constituer les files du périthalle”. This, however, is, in my opinion, not characteristic of the species, as will be seen in my fig. 133. The cells of the hypothallium which, according to Mme LEMOINE, are 3—4 μ thick, I generally found somewhat thicker, 3.5—6 μ , in specimens from the Limfjord 5—6 μ , the length 12—18.5 μ . The cells of the perithallium I found 4—6 μ thick, 4—13 μ long. In the perithallium also numerous transverse fusions occur, but as the cells are closely joined, the fusion canals are very short.

The sporangial conceptacles are very crowded, in particular in f. *typica*; they measure 200—300 μ in diameter. The flat roof is, according to FOSLIE, intersected by 25 to 35 muciferous canals, which is in accordance with my observations; I have, however, met with up to 45 canals. Transverse fusions between the cells of the roof are frequently met with. The sporangia which are otherwise always tetrasporic, are also normally so in the Danish waters. Conceptacles with disporic sporangia only, however, not infrequently occur (fig. 134 A). It might be suggested

that the sporangia in such cases were not quite ripe, and would later on have been divided into four spores, but as in other cases the divisions have shown to be al-

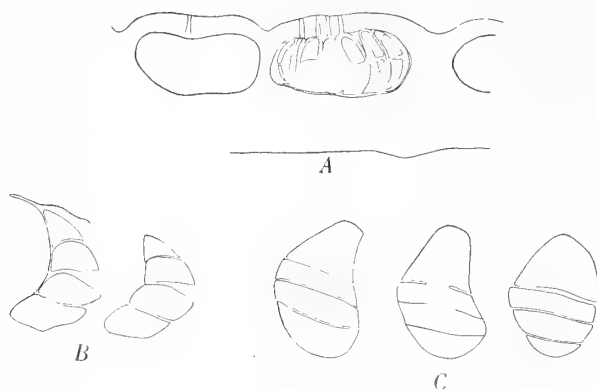


Fig. 134.

Lithothamnion Lenormandi. A, vertical section of crust with sporangial conceptacles. B, tetrasporangium in two consecutive sections. C, tetrasporangium in three consecutive sections.

A 63:1. B 200:1.

—200 μ). In the specimens from the first named locality collected in September they were fully developed and showed a rather complicated structure, the spermatia being produced on the ultimate ramifications of dendroid systems of filaments given off from several points of the inner surface of the conceptacle, from the bottom and from the upper side as well (Plate III fig. 2). The structure of the antheridial conceptacles is thus rather similar to those of *Lith. polymorphum* described by HEYDRICH (Lith. Helg. p. 65, Taf. II fig. 1—3). The dimensions of the spermatia seem to be $3 \times 4 \mu$.

The cystocarpic conceptacles are hemispheric to conical, 320—350 μ in diameter. It is remarkable that the carpospores are not only produced at the periphery of the bottom of the conceptacle but from the whole face of the floor, a fact by which our species differs, as it appears, from the type not only of the genus but also of the family. The carpospores are 50—63 μ long, 21—32 μ broad¹.

¹ HEYDRICH has in 1911 (l. c.) established a new genus, *Squamolithon*, founded on *Lithothamnion Lenormandi*,

most simultaneous (fig. 134 C) it seems most probable that disporic sporangia occur besides tetrasporic ones, as in several other species. Sporangia with 4 spores found in the Limfjord and in the Kattegat were 100—112 μ long, 34—48 μ broad; in specimens collected in Bramsnæs Vig (Ise Fjord) they were only 53—91 μ long, 14—25 μ broad.

Antheridial conceptacles were found in specimens from Staffans Flak in the Sound and from Bramsnæs Fjord. In both cases they were 300—350 μ in diameter, thus much larger than stated by FOSLIE (150

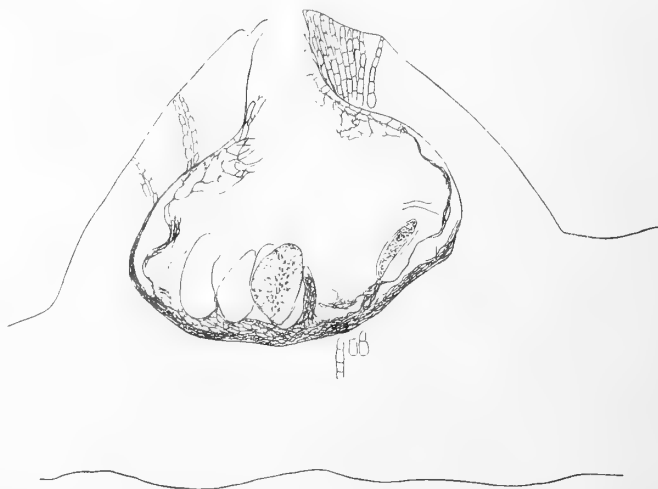


Fig. 135.

Lithothamnion Lenormandi. Vertical section of cystocarpic conceptacle. 200:1.

This species occurs on stones and rocks, and on shells of molluscs (*Mytilus*, *Modiola*, *Trochus*, *Littorina*), from ordinary water-mark to 19 meters depth. Almost all the specimens belong to f. *typica*, a few only have been referred by FOSLIE to f. *sublævis*, which differs by smoother surface and less crowded sporangial conceptacles. It was rather surprising to me to find the species growing at low-water mark on the granitic rocks of Bornholm, where the salinity of the water is about 7—8 ‰ only. It was here fairly typical though sterile, and with numerous adventitious fronds, and occurred in fairly great numbers. In the other locality in the Baltic (RG), only sterile but rather large crusts were found.

Ripe sporangia have been met with in July (partly together with undivided) and September. Antheridial conceptacles with spermatia were found in July and September, and ripe cystocarpic conceptacles in July.

Localities. **Ns**: Thyborøn, groin no. 58, stunted specimens. — **Lf**: Søndre Røn by Lemvig; Thisted harbour (!, C. H. Ostenfeld); Sallingsund (Th. Mortensen); **LS**¹, off Bjørndrup, east of Mors, 5,5 m. — **Kn**: Frederikshavn, at low-water mark; Trindelen, 15 m (small spec.). — **Ke**: EU, Lille Middelgrund, 14 m (small spec.); IA, Store Middelgrund, 16 m. — **Ks**: Ourø Sund; Bramsnæs Fjord. — **Lb**: At Lyngsodde off Middelfart, 15—19 m, large fertile crusts. — **Sb**: GP, at Halskov Rev, 9,5—11,5 m; Avernakhage by Nyborg, low water. — **Sm**: VC, Venegrund, 3—5,5 m. — **Su**: TF¹, Staffans Flak, 11—13 m; PS, off Charlottenlund, 5,5 m. — **Bm**: RG, 6 miles N.N.W. of Falsterbo lighthouse, 11,5 m. — **Bb**: Helligdomsklipperne, Rø, Bornholm.

3. *Lithothamnion Sonderi* Hauck.

Hauck, Meeresalgen, p. 273, Taf. III, fig. 5; Foslíe, Norweg. Forms, 1895, p. 127; Heydrich, Lithoth. Helgol., 1900, p. 77, Taf. II fig. 20—22; Foslíe, Remarks, 1906, p. 23; Lemoine, Structure, 1911, p. 96.

Though this species has been met with in a number of different localities in the Danish waters, it has in most cases been found only in small quantities together with other species. I have therefore only little to communicate with regard to it, but must refer to the descriptions of HAUCK, FOSLIE and Mme LEMOINE.

As pointed out by FOSLIE and Mme LEMOINE, the hypothallium is feebly developed. According to the last-named author it consists only of a single layer of cells; "les autres se relèvent très rapidement pour former le périthalle". The ascending filaments may, however, rise more gradually, and the hypothallium may then consist of two or three cell-layers (fig. 136 B). The hypothallic cells measured 5—7 μ broad, 15—21 μ long; those of the vertical filaments I found to be 3,5—7 μ broad, 5,5—11 μ long. These measurements are somewhat smaller than those of FOSLIE and Mme LEMOINE. Transverse fusions between the cells are very frequent in the perithallium. In sections stained with hæmatoxyline the middle lamellæ are very distinct. In the same sections the horizontal limiting lines are intensely stained; their course is somewhat irregular (fig. 136). Older crusts may have a considerable number of layers. The cells of the under part of the frond are often filled with

and characterized principally by cytological statements relating to the development of the cystocarp. These statements are, however, very insufficiently supported, and I have had no opportunity of verifying them.

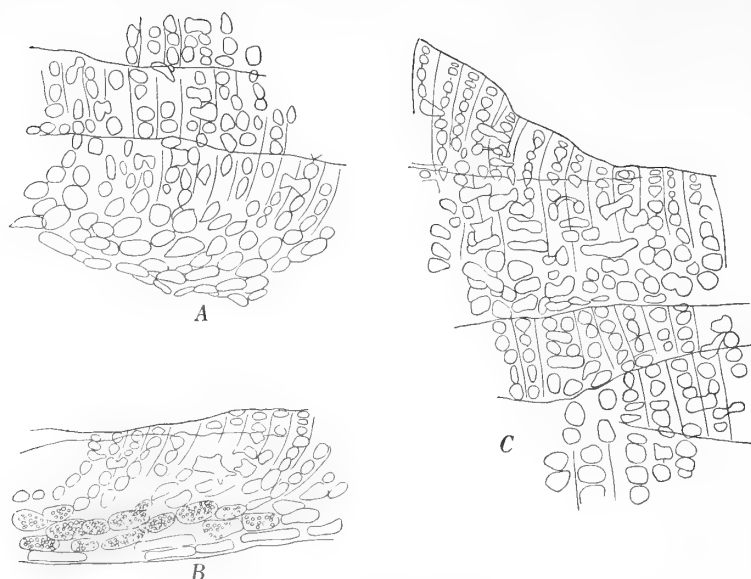


Fig. 136.

Lithothamnion Sonderi. A, vertical section of frond with a single-layered hypothallium. B, thinner crust with two or three layers of cells in the hypothallium, containing starch grains. C, upper part of a thick frond with an uneven surface. 350:1.

les, but seems otherwise to agree with this species. The conceptacles of sporangia were however a little smaller than usual, 260–280 μ in diameter (inner diameter about 200 μ). The sporangia were tetrasporous, in some cases showing vertical divisions (fig. 137).

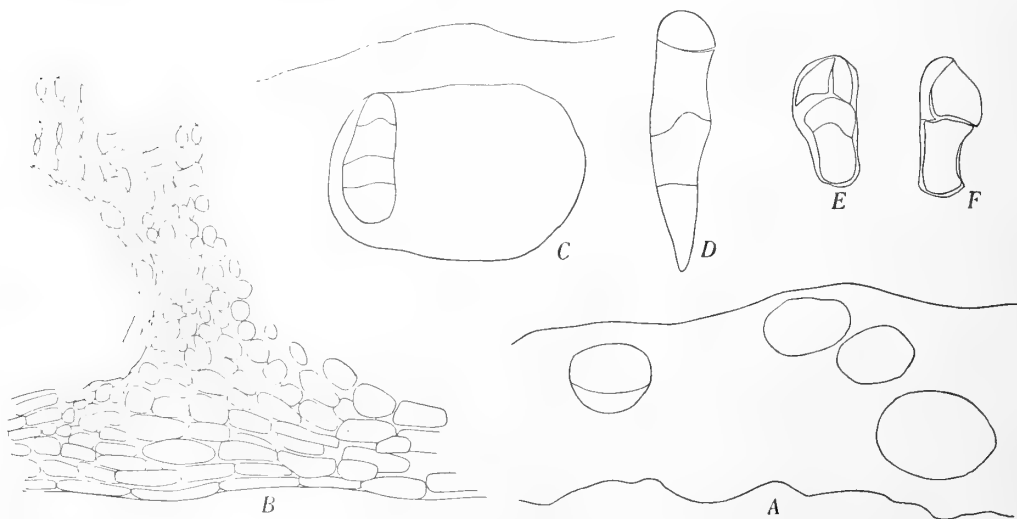


Fig. 137.

Lithothamnion Sonderi (?), from Halskov reef (no. 3171). A, vertical section through a crust with overgrown conceptacles. 63:1. B, part of a similar section with an overgrown conceptacle, showing the hypothallium. 350:1. C, sporangial conceptacle with sporangium. 205:1. D–F, sporangia with anomalous divisions. 205:1.

starch grains, but in other cases starch is wanting.

Fructiferous specimens I have had no opportunity to submit to closer examination. The sporangial conceptacles are, according to FOSLIE very little prominent, 300–500 μ in diameter, not overgrown, the sporangia tetrasporous.

A crust dredged at the beacon of Halskov Rev in Nov. (no. 3171) and referred by FOSLIE to this species, differs by having overgrown sporangial conceptacles,

The species forms crusts on stones and gravel, in depths from 5 to 24,5 meters. In one case it was found growing on a dead specimen of *Lithothamnion calcareum*. It has been found with sporangial conceptacles and cystocarpic conceptacles in May and September.

Localities. **Sk**: Off Hirshals, 13 met. (F. Børgesen). — **Lf**: ZY, Nissum Bredning, 5 met. (determination uncertain). — **Kn**: Herthas Flak, 20—23 met.; FF and TR, Trindelen, 23,5 and 15 met. — **Ke**: IP and IL, Fladen, 20,5—24,5 met.; IK, Lille Middelgrund, 17—19 met. — **Sb**: GP near the light-buoy at Halskov Rev (no. 3171, see above); Strandby reef, W. side of Langeland (?). — **Sm**: VC, Venegrund, 4—5,5 met.

4. *Lithothamnion glaciale* Kjellm.

F. R. Kjellman, Norra Ish. algfl. p. 123 (93) tab. 2 and 3. Foslie, Norw. Forms p. 13; Remarks p. 26. Mme P. Lemoine, Struct. p. 92.

Nearly all the rather numerous Danish specimens referred to this species have been determined by FOSLIE, who received them from me at different times and accordingly gave them different names. In 1895 he described and figured Norwegian specimens, corresponding exactly to those mentioned here as var. *Granii*, under the name of *L. flabellatum* f. *Granii*. Later on this variety was referred to *L. glaciale*, an opinion which has only been expressed in Rev. Surv. (1900, p. 11, where after the name *L. Granii*, which is here a nomen nudum, is added: “(*L. glaciale* f. ?)”). As late as in 1905 FOSLIE referred specimens of these algæ to *L. glaciale*, partly to f. *Granii*, partly to other forms. But in the same year (Remarks p. 59,¹) FOSLIE established *L. Granii* as a distinct species. That he has been uncertain at the last as to the limitation of the species can be concluded from the fact that the same species, on p. 10 of the same paper, is mentioned as *L. glaciale* f. *Granii*. It is easy to understand that it has been difficult to come to a decision as to the delimitation of species when considering that FOSLIE (Remarks p. 28) “found it almost impossible to draw any line between *L. Granii*, admitted below, and *L. glaciale*”. L. c. p. 59 is said, as to the relation between *L. Granii* and *L. tophiiforme* f. *divergens*, that there are many specimens “which are quite like each other in almost every respect, but that the specimens of one species show a somewhat greater tendency in one direction and the other in a different one”. It is however not to be seen in the named paper on which characters the difference between the two species really rests, save that *L. Granii* has thinner, usually more ramified branches. Some Danish specimens formerly determined as *L. glaciale*, in part as f. *colliculosa*, are now (Remarks p. 34) referred to *L. colliculosum* which is here regarded as a separate species, while he had formerly considered it a form of *L. glaciale*; a description of it is given, but he does not emphasize how it differs from *L. glaciale*. As I cannot see any distinct difference between these specimens and some of those referred by FOSLIE to *L. Granii* I prefer to adhere to FOSLIE’s somewhat older opinion in regarding *L. colliculosum* and *L. Granii* as varieties of *L. glaciale*.

¹ FOSLIE’s “Remarks” appeared however only in 1906.

var. *colliculosa* (Fosl.)

Lithothamnion colliculosum Fosl., Contrib. II, 1891, p. 8, tab. 3 fig. 1 ex p.; Norw. Forms, 1895, p. 75 ex p.; Remarks, 1905, p. 34.

FOSLIE has referred to *L. colliculosum* specimens from two localities in the western part of the Limfjord. They resemble arctic specimens of *L. glaciale* with not much developed processes which are thicker than in *L. glaciale* f. *Granii* and, as it seems, less closely placed, up to 4 mm high. The crust is well developed, expanded, and contains conceptacles. These specimens were found growing on *Mytilus* and stones.

var. *Granii* (Fosl.)

Lithothamnion flabellatum K. Rosenv. f. *Granii* Fosl., Norw. Forms (1895) p. 70, tab. 17 fig. 1—7, tab. 22 fig. 1.

L. Granii Fosl., Remarks (1905) p. 59.

All the other Danish specimens belong to this variety. It differs from the typical *L. glaciale* by more closely placed, thinner and often more ramified branches. The thickness of the branches, however, varies somewhat; it is lesser, for instance in f. *reducta* Fosl. The crust is usually much developed and may be widely expanded over the substratum. In the latter case the processes are frequently small, wartlike and rather spread, and the crust then frequently contains numerous conceptacles (fig. 138 A). When growing on pebbles on gravelly bottom it often completely encompasses the pebble, and when this is small, branches may project from it at all sides. Usually however, they grow principally to one side, viz. upwards, and these upward growing branches may branch repeatedly. In branching they often have a tendency to take globular form, and such globular branch-systems may at last be loosened, the conjunction with the pebble being given up. On gravelly bottom, loose individuals, “Ægagropila-forms”, exactly similar to these branch-systems, are often found (Plate IV figs. 1—4). H. JÓNSSON assumes that the loose Ægagropila-forms of *L. Ungerii* and *L. tophiforme* are produced in the same manner off the shores of Iceland¹. Probably loose individuals may also arise by division of other loose ones. On gravelly bottom the plurality of the individuals may be loose (e. gr. Lille Middelgrund, Ke). In the inmost localities in the Danish waters (Ks, Sa, Lb, Sb, Su) only specimens with well developed crust but small processes were met with.

The crust contains a hypothallium composed of few cell-layers from which obliquely ascending filaments continuing in the perithallium are given off. The cells of the hypothallium were in the specimen examined 20—22 μ long, 5—7 μ broad. Mme LEMOINE states the dimensions for *L. glaciale* to be 12—18 \times 2 μ . The latter figure, however, must be presumed to be exceptionally low. Mme LEMOINE further states that the hypothallium gives off a layer of rhizoids or rectangular cells inclining against the substratum; this I have not found in the Danish specimens

¹ H. JÓNSSON, Om Algevegetationen ved Islands Kyster. Botan. Tidsskrift 30. 1910 p. 322. — The Marine Alg. Veg. of Iceland. The Botany of Iceland, Part I, 1912 p. 154.

(comp. fig. 138). The same author finally states that the filaments of the hypothallium are "formées de cellules arrondies, très serrées les unes contre les autres, de sorte qu'il est impossible de suivre le trajet de chaque file". As will be seen in my fig. 138, the filaments of the hypothallium are very distinct in well developed crusts. The cells of the perithallium are roundish, sometimes almost globular, usually however longer than broad, $7-10,5\mu$ long, $4-8\mu$ broad. They are often fused together two or three in a horizontal direction. The crust is divided in zones by horizontal lines stained intensely by hæmatoxyline.

The branches have a similar structure to the perithallium in the crust. The cells are usually oblong or rectangular with rounded angles. They are sometimes situated more closely together in the outer layer than in the inner, that is to say, the walls are thinner (fig. 139 A). The cells are $5-7\mu$ broad, $7-11\mu$ long. Transverse fusions between the cells are frequent, often connecting several cells; in tangential sections they are often especially numerous and appear as irregular, curved, partly ramified formations (fig. 139 C). In transverse sections of the central tissue they

may present a similar appearance (fig. 139

B). These

cell-fusions contain, at least usually, only one nucleus (comp. p. 211, fig. 128). Starch grains appear very irregularly, without relation to the layers. The cells may contain a greater or smaller number of them, and they may consequently be placed closely together; but composed grains (comp. Mme LEMOINE, l. c. p. 94) do not seem to occur.

Conceptacles are frequently found, but only sporangial conceptacles were observed. They are usually placed on the branches,

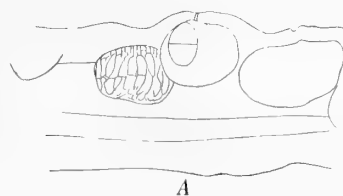


Fig. 138.

Lithothamnion glaciale var. *Granii*. A, vertical section of crustaceous frond with sporangial conceptacles. 65:1. B, part of the same section, showing the hypothallium and a peripheral part of a conceptacle. 350:1.

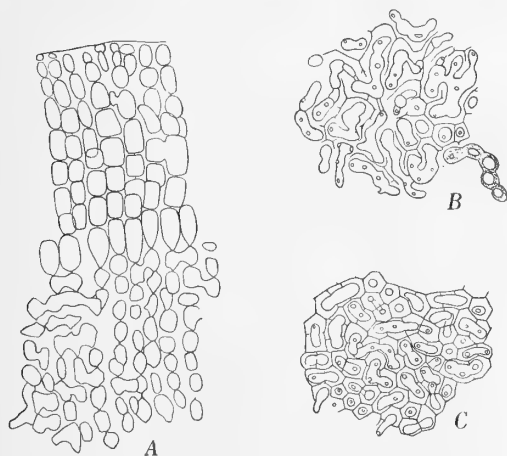


Fig. 139.

Lithothamnion glaciale var. *Granii*. A, longitudinal section of upper end of a branch. B, transverse section of branch, from the centre. C, tangential section of branch. 400:1.

especially on the upper part of them, but they may also occur in the crusts when these are much developed. They are slightly prominent, about $260\text{--}350\ \mu$ in diameter. The conceptacles in the crusts show the same aspect as those of the branches (figs. 138, 140). By proportionally few countings I found 30–60 muciferous canals in the roof. The conceptacles are usually gradually overgrown and immersed in the tissue of the branch, and this is also the case with those of the crusts. In such immersed conceptacles the septa between the sporangia are frequently visible for some time (Plate III fig. 4). Slime-strings may also remain distinct after the im-

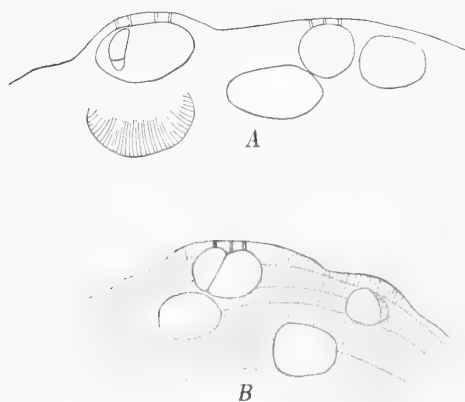


Fig. 140.

Lithothamnion glaciale var. *Granii*. Transverse sections of branches with tetrasporangial conceptacles. In A an immersed conceptacle filled out by tissue from the bottom. 65:1.

mersion. Conceptacles filled out by tissue produced from the bottom of the cavity frequently occur (fig. 140 A). The sporangia are always two-parted, $70\text{--}110\ \mu$ long, $39\text{--}50\ \mu$ broad.

As mentioned above, the var. *colliculosa* has only been found in two localities in the Limfjord while a specimen found in a third locality of the same fjord seems to belong to the var. *Granii*. The specimens from the other localities were all referred to this variety, which is best developed in the eastern Kattegat where it was found in most of the localities in rather great quantities as branched specimens, partly loose. In the inner water it occurs only in the form of crustaceous specimens with short, often densely placed wartlike processes. The species has been found growing on stones,

gravel and shells, in the Limfjord in 5,5 meters' depth, in the Kattegat in 17–30 m, in the Samsø waters in 9,5–19 m, in the Great Belt in 19 m and in the Sound in 34 meters' depth. Ripe sporangia have been found in April–May.

Localities.

var. *colliculosa*. **Lf**: north of Rønne by Lemvig (6874); Nissum Bredning off Helligsø tile-kiln, 5,5 m (C. H. Ostenfeld).

var. *Granii*. **Lf**: western Limfjord, on an oyster-bed, brought up by a diver; form with rather long unbranched branches. — **Kn**: FG, Herthas Flak; off Frederikshavn; TR, Trindelen. — **Ke**: IR and ZI, Groves Flak; IL and IQ, Fladen; IH and IK, Lille Middelgrund, in quantity, on pebbles and gravel and loose; IA, Store Middelgrund (! and F. Børgesen). — **Km**: Læsø Rende, a crustaceous specimen with scarce low papillæ, on a piece of coal; ND, N.E. of Fornæs. — **Ks**: HO, E. of Hesselø; EO, 26,5 m; A, S.E. of Hesselø. — **Sa**: E. of Samsø (C. Løfting); BE, off Sletterhage, 10 m; KM, E. of Øreflippen; PL, Wulfs Flak; north side of Refsnæs, 19 m (C. H. Ostenfeld); MS, S. of Klothagen by Endelave. — **Lb**: Middelfart. — **Sb**: MO, S.W. of Refsnæs (? young specimens); near Sprogø, 19 m (C. H. Ostenfeld). — **Su**: Øretvisten (Johs. Schmidt); on the beach by Hornbæk (Mrs. M. Fibiger), probably brought by fishermen from the southern Kattegat; bM, 22,5 m, crusts up to 1,5 cm in diameter with small wartlike processes.

5. *Lithothamnion norvegicum* (Aresch.) Kjellman.

Kjellman, N. Ish. algfl. p. 122 (93), pl. 5 fig. 9–10; Foslie, Remarks 1905, p. 65; Lemoine, Structure, 1911, p. 108 fig. 11 and 48.

Lithothamnion calcareum Ellis et Sol. var. *norvegicum* Areschoug, Observ. phycolog. III. 1875, p. 4.

Lithothamnion coralloides Crouan f. *norvegica* (Aresch.) Foslie, Norw. Forms 1895, p. 62, tab. 16 fig. 1—11.

According to FOSLIE, this species is almost always freely developed on the bottom (Remarks p. 66). The specimens found in the Danish waters were all loose. FOSLIE has referred them all to f. *pusilla* which, in his opinion, is "perhaps the typical form of the species". He observes however (l. c. p. 64 and 67) that they "partly approach stunted forms of *L. nodulosum* f. *gracilescens*". They give off branches in all directions and become up to 3 cm (more rarely 3,5 cm) in diameter.

The anatomical structure is not very different from that of *L. glaciale*. According to Mme LEMOINE, the cells are in the greater part of the frond rectangular, while

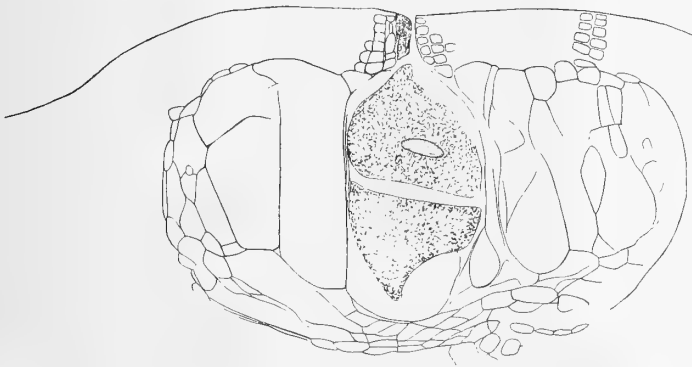


Fig. 141.

Lithothamnion glaciale var. *Granii*. Vertical section of sporangial conceptacle with ripe sporangium. 350:1.

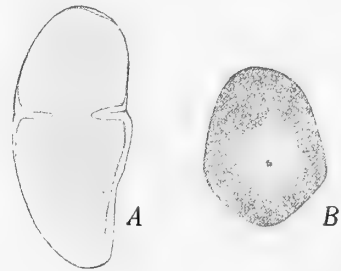


Fig. 142.

Lithothamnion glaciale var. *Granii*. A, sporangium; the process of division not yet completed. B, ripe spore. 390:1.

near the periphery they are ovoid. This may be so, but it frequently happens that rectangular cells in the inner parts of the frond alternate with ovoid ones (fig. 143 C). The change may take place at the distinctive lines between the zones or independently of them. The zones are limited by somewhat irregular lines staining deeply by hæmatoxyline, and the staining power of the single layers may sometimes be a little different, but the limit between such zones is not always marked as a blue line (fig. 143 C). The irregular course of the distinctive lines is probably in accordance with the irregularity of the increase. Transverse fusions between the cells frequently occur, though not so frequently as in *L. Granii*, and not uniting so many cells as in that species. The cells are 8—14 μ long, 6—9 μ broad; the rectangular ones are 11—14 μ long, 6—7 μ broad. The central tissue shows a different aspect in transverse section, according to whether the section has fallen in a zone with rectangular or with roundish cells. The appearance of the starch is variable. It may appear in great quantities in the more deeply stained and in the less stained zones as well, all the cells being filled with starch grains except the outermost ones. In other cases it is entirely or almost entirely wanting.

Conceptacles were found in specimens from most of the localities named below;

they were in all cases, when examined, empty and more or less destroyed. I found sporangial conceptacles 300μ or somewhat more in diameter.

On stony bottom in 10—21 meters depth, usually associated with *Corallina officinalis*, in some places abundantly. Only found in the Samsø area.

Localities. **Sa:** KI, south of Hjelm; PH, Lindholms Dyb; east of Samsø (Løfting); Stenpladen off Sletterhage (G. Winther); BE and BF off Sletterhage.

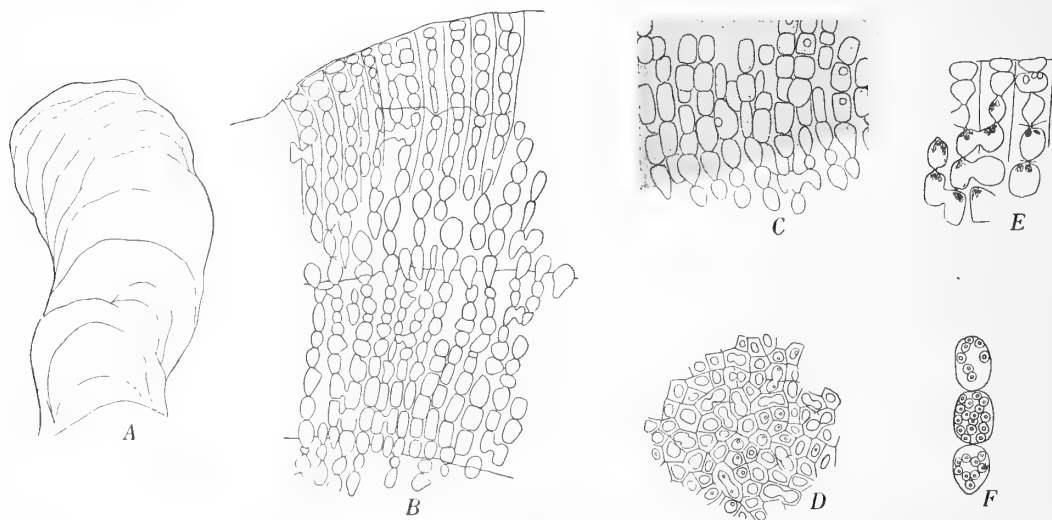


Fig. 143.

Lithothamnion norvegicum. A, axile longitudinal section of branch. B, part of a similar section near the top. C, part of axile longitudinal section of frond. The upper part of the tissue was deeper stained by hæmatoxyline than the under part. The fusion canals with the over-lying cells appear as round figures. D, transverse section of the central tissue of a branch. E, cell-rows from the periphery of a section of a branch. F, cells with starch grains.

A 31:1; B D 350:1; E, F 560:1.

6. *Lithothamnion calcareum* (Pallas) Aresch.

J. Areschoug in J. Agardh, Sp. g. o. II, 1851, p. 523. Foslie, Lith. Adriat. Meeres u. Marokko, Wiss. Meeresunt. VII. Heft 1, 1904, p. 13 and 32, Tafel II; Remarks, 1905, p. 67; Mme P. Lemoine, Répartition et mode de vie du Maërl (*Lithothamnion calcareum*) aux environs de Concarneau (Finistère), Annales de l'Institut océanographique, tome I, fasc. 3, 1910; Structure, 1911, p. 102.

Millepora calcarea Pallas, Elench. Zooph. 1766, p. 265.

Lithothamnion coralloides Crouan, Flor. Finist., 1867, p. 151, pl. XX no. 133.

This species has been found in a few localities, in particular in the eastern Kattegat, but always only in loose specimens without or with imperfectly developed conceptacles. It is, as elsewhere, rather variable. The Danish specimens have been referred by FOSLIE to the following forms.

1. *F. squarrulosa* Foslie, Lith. Adr. Meer. Taf. II fig. 1—4; Lemoine, Répart. du Maërl fig. 1, 5, 14, Structure pl. I, fig. 5. To this form approaches f. *coralloides* (Crouan) Foslie, Norw. Lith. p. 62 pl. 16 figs. 24—25, 27—31. — This form has terete branches spreading in all directions.

2. *F. compressa* (McCalla) Foslie, On some Lithothamnia, 1897, p. 9, Lith. Adr.

Meer., 1904, p. 32 Taf. II figs. 15—23; Lemoine, Répart. du Maërl pl. I fig. 14. — It is “flabellate, the branch-systems spreading like a fan in all directions from the centre of the frond almost in one plane. Sometimes it forms rather thick and compressed fronds” (Foslie, Remarks p. 69).

3. *F. palmatifida* Foslie, Some new or crit. Lith., 1898 p. 6, Remarks p. 69; Lemoine, Répart. du Maërl pl. I fig. 3, Structure, p. 104. — “With branches more distant and palmate” (Foslie, 1905).

4. *F. subsimplex* (Batt.) Foslie, Norw. Lithoth. 1895 p. 62 pl. 16 figs. 38—42; Lemoine, Rép. du Maërl pl. I fig. 10, Structure p. 104. Frond “simple or feebly branching” (Foslie Remarks).

There are no distinct limits between these forms, which occur together at the same locality.

The structure has been mentioned by Mme LEMOINE (Structure p. 105), whose description may here be referred to. It will suffice to add some small remarks. According to Mme LEMOINE there is always at the periphery a cortex composed by 5 or 6 layers of cells which are rectangular, while the other cells are ovoid. I have certainly observed such a cortex in some cases, but it does not occur normally; the outer tissue, in the sections examined by me, more frequently consisted of cells of the same shape as those of the inner tissues (fig. 144). Transverse fusions between the cells are very frequent. The size of the cells is somewhat variable, generally they are 9—13 μ long, 5—7 μ broad. Starch grains were found in great quantity in all cells except the outermost. On being treated with acetic acid and iodine in potassium iodide the starch grains swelled and filled the cells with a homogenous violet-brown mass.

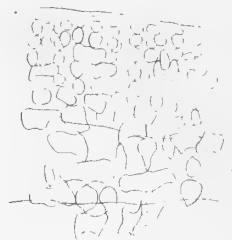


Fig. 144.
Lithothamnion calcareum,
Transverse section of
frond. at the periphery.
Several transverse fusions.
350 : 1.

In a specimen from Trindelen (ZB, July) empty conceptacles were found, the kind of which could not be determined; they were almost entirely immersed. Possibly they were antheridial conceptacles.

The species has been found in 17 to 30 meters depth, on gravelly or stony bottom, generally associated with other *Lithothamnia*, in particular *Lith. glaciale*, and with *Corallina officinalis*.

Localities. **Kn**: ZB, near Trindelen, 28—30 meters. — **Ke**: IL and IP, Fladen; IK, Lille Middelgrund. — **Km**: Læsø Rende, clayey bottom, small fragments (C. H. Ostenfeld).

Subgenus *Phymatolithon* Foslie.

In 1898 FOSLIE (Syst. Surv., p. 4) established the genus *Phymatolithon*, founded on *Lithothamnion polymorphum*, and distinguished from the genus *Lithothamnion* chiefly by immersed conceptacles and the roof of the sporangial ones being depressed or cup-shaped. Later on he has referred *L. lævigatum* and another species to the same genus. I must, however, agree with Mme LEMOINE, who observes (Struct.

p. 63) that the characters pointed out by FOSLIE are not sufficient for generic distinction but only for separation of sections beyond the genus. The roof of the sporangial conceptacles is frequently scarcely immersed, and it is often, particularly in *L. lævigatum*, convex within a feebly elevated border.

7. *Lithothamnion polymorphum* (L.) Aresch.

J. E. Areschoug in J. Agardh, Spec. II, pars 2, 1852, p. 524 ex parte; Rosanoff, Mélobés., p. 99; Strömfelt, Algveg. Isl., 1886, p. 19, pl. I, fig. 1—3 (sporangia); Foslie, Norw. Forms, p. 86, pl. 17, fig. 17—23 (f. *tuberculata*, f. *valida* and f. *papillata*); Mme P. Lemoine, Structure, 1911, p. 87, pl. V fig. 2.

Phymatolithon polymorphum (L.) Foslie, Syst. Survey, 1898, p. 4, Remarks, 1906, p. 75.

Eleutherospora polymorpha (L.) Heydrich, Lith. Helgol., 1900, p. 65, Taf. II, fig. 1—14.

The species forms more or less irregular crusts extended over larger boulders, of a thickness of up to 6 mm. As to the structure reference may be made to the

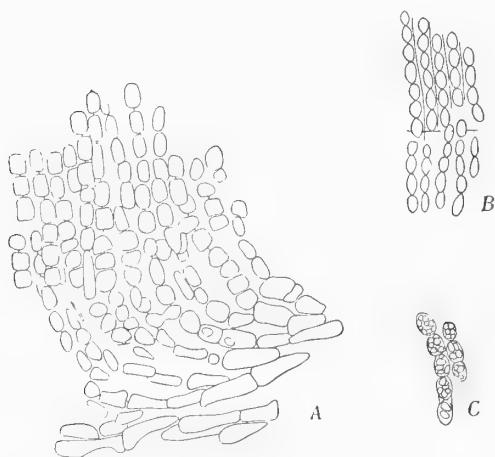


Fig. 145.

Lithothamnion polymorphum. A, vertical section of frond showing the hypothallium and the lower part of the perithallium. B, vertical filaments of another frond with narrower cells. C, cells of perithallium with starch grains. 350:1.

papers of FOSLIE (1906) and Mme LEMOINE. The hypothallium is shown in fig. 145 A. The cells of the perithallium are somewhat variable in thickness, 4—7 μ , in some specimens proportionally narrow, 4—5 μ (fig. 145 B). Mme LEMOINE mentions as an interesting character that the starch grains are single, very small and grouped at the ends of the cells. This is, however, not always so, for I found the starch grains up to 3 μ in diameter, and in some parts, frequently the greater part of the crust, all the cells were filled with starch grains, while they were totally wanting in others. Particularly abundant starch grains were found in the tissue filling out the emptied conceptacles in the inner part of the crusts. Cells containing starch grains at the ends of the cells but not in the middle were indeed observed, but only as exceptions. Transversal fusions between the cells of the perithallium occur here and there.

The increase in thickness of the crust normally takes place by continued growth of the perithallium, which may show several zones limited by horizontal, but somewhat irregularly running lines. In older crusts a more complex structure may be found, the frond being composed of two or more crusts one over the other, each with a particular hypothallium. This arises through cessation of growth in thickness in certain parts of the perithallium, which become overgrown by new crusts developing from other parts of the crust. This structure has been mentioned by Mme LEMOINE (Struct. p. 24 and 88, pl. V fig. 2), who appears to consider it as

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arising through differentiation of the same crust. In the new overgrowing crusts, the limiting lines between the successive zones of tissue are more or less inclined. This complex structure is not always found even in old fronds. Crusts up to 1,5 mm in thickness showing only one hypothallium are frequently met with,

The muciferous canals of the sporangial conceptacles open outwards in a low hollow surrounded by a slightly elevated border, but it is sometimes very slight or

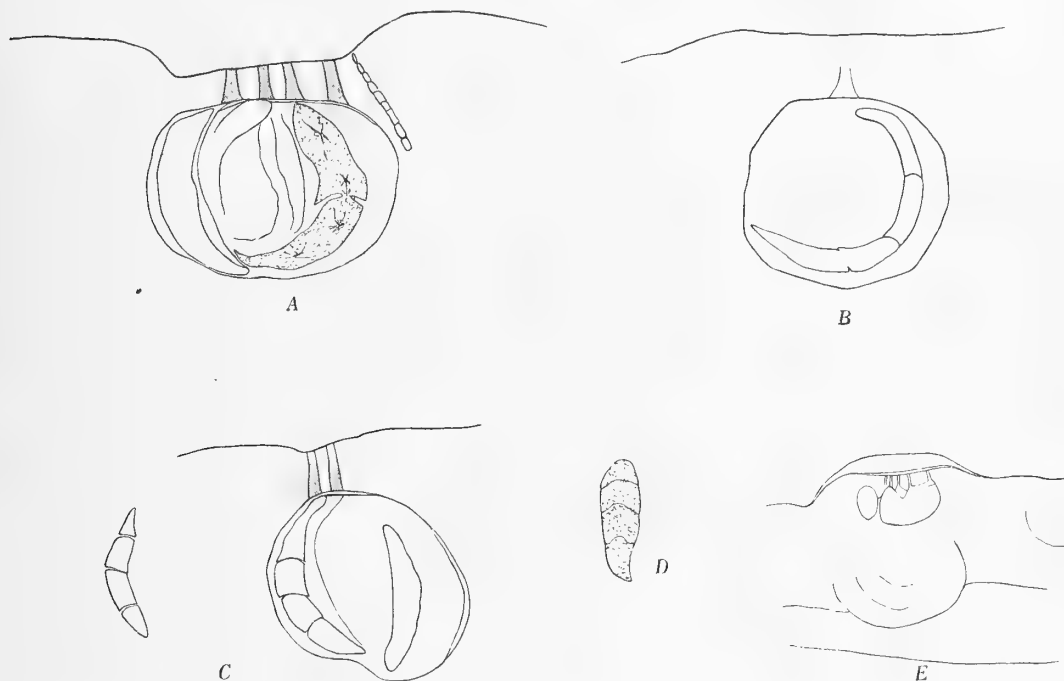


Fig. 146.

Lithothamnion polymorphum, vertical sections of sporangial conceptacles, A, the first division of the sporangium is not accomplished, the following not yet begun. B, with a very long sporangium. C, conceptacle with undivided and fully divided sporangia. D, ripe sporangium. E, empty sporangial conceptacle with covering tissue; below, limiting line of zones and outline of empty conceptacle filled with regenerative tissue. A—D 200:1; E 63:1.

scarcely perceivable, if at all (fig. 146). The sporangia are at least divided into 4 spores. As stated by FOSLIE, the sporangia are $80-110\mu$ long, $25-45\mu$ broad; the outermost ones, however, reach a greater length (fig. 146). After the evacuation of the sporangia, the conceptacles become sunk in the crust by continuation of the growth in thickness of the frond, but their surroundings may then behave in different manners. 1) The filaments of the roof grow upwards in accordance with those of the surrounding frond, and the conceptacle forms an empty round hole. 2) The roof falls into decay and the conceptacle is filled more or less completely by tissue growing inwards from the tissue which is developed by increase in thickness of the surrounding part of the frond and united over the conceptacle. 3) The conceptacle is completely filled by a tissue produced from the bottom of the con-

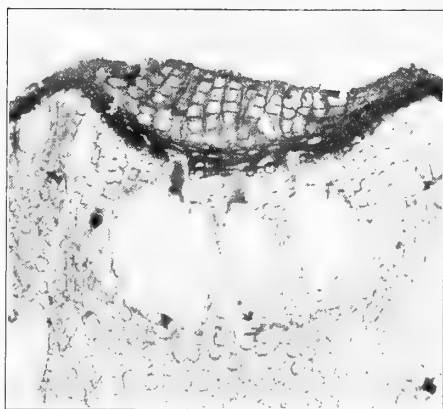


Fig. 147.

Lithothamnion polymorphum. Vertical section of emptied sporangial conceptacle, showing two muciferous canals and the covering tissue. About 350:1.

THURET states (Ét. phyc., 1878, p. 91) that the spermatia resemble those of *Jania rubens*.

The cystocarpic conceptacles are, according to FOSLIE, at first convex, but they are not always so, for fairly young, totally immersed conceptacles may be found (fig. 148). As to the development of the cystocarp more detailed statements are given by HEYDRICH (l. c. p. 70) which are in several respects in discordance with those of SOLMS for other *Corallinaceæ*. They very much need a critical trial, but as I have had only dried specimens at my disposal I can only throw little light upon the matter. Before fertilization the concave bottom of the conceptacle is covered with numerous procarys which are two-celled, as shown by HEYDRICH (fig. 148, Plate III fig. 5). These filaments are intensely coloured by hæmatoxyline. The lowest cell is probably an auxiliary cell, as maintained by HEYDRICH, and this is also in accordance with the statements of MINDER for *Choreonema* (Fruchtentw., p. 12). This cell may be rather long (fig. 148 C). The

ceptacle. The newly evacuated conceptacles are sometimes covered by a peculiar, rather thick tissue, which is sharply marked off from the roof (fig. 146 E, 147, Plate III fig. 6). Its cells are frequently broader than those of the roof, (fig. 147). In a living state this covering tissue appears as a white dot. It has been mentioned by FOSLIE (Remarks, p. 78). A similar tissue also occurs over the sexual conceptacles. Its signification is unknown.

Antheridial conceptacles I have not seen; they have been mentioned by HEYDRICH (1900, p. 68, Taf. II fig. 1—3) and Foslie (1905). According to the first named author, the spermatia are produced from branched filaments given off from the inner side of the conceptacle, as it seems, in a similar manner as in *L. Lenormandi*.

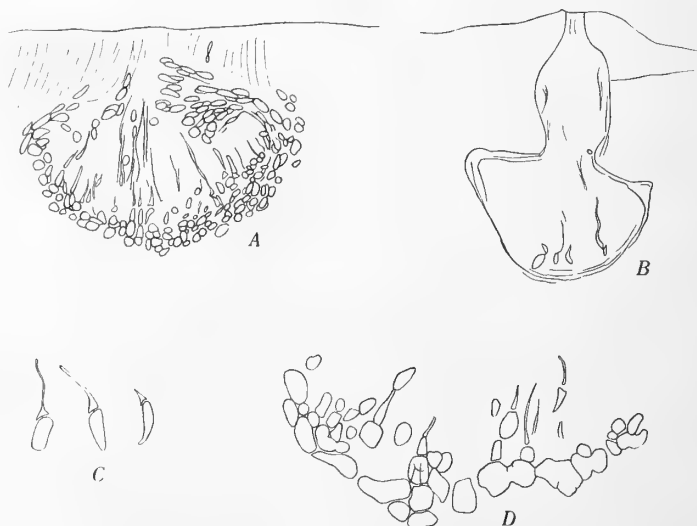


Fig. 148.

Lithothamnion polymorphum. A, vertical section of female conceptacle with carpogonia. B, similar, with a rather long neck. C, procarys. D, vertical section of the bottom of a female conceptacle, showing fusions between the cells. A, B 200:1. C, D 350:1.

wall between the two cells is more or less oblique, but a hypogynous cell is not cut off from the lowermost end of the carpogonium as in *Choreonema*. I have not been able to follow the development of the carpogonia after fertilization, but it must be said that there is nothing to support the supposition of HEYDRICH that each auxiliary cell becomes a carpospore. The only thing which might favour this view is the fact that the carpospores are produced not only at the periphery but also from the central part of the floor of the conceptacle, as shown by HEYDRICH (l. c. fig. 12), and as I have also observed it (fig. 149). But the carpospores do not arise singly; they are produced in short rows, as shown by earlier authors (SOLMS, PILGER, MINDER) for other Corallinaceæ. This is shown in fig. 149 where a smaller (younger) carpospore is situated under the most developed ones; they have undoubtedly been produced successively by the sporophyte, but the behaviour of the latter could not be stated. The low cells visible



Fig. 149.

Lithothamnion polymorphum, vertical sections of cystocarpic conceptacles with carpospores. A 200 : 1. B 350 : 1.

under the youngest carpospores are probably parts of the sporophyte (or of the fusion cell, if SOLMS' view is correct); or might there perhaps be more than one sporophyte? The cells situated below the procarps may show lateral fusions (fig. 148 D), but it is doubtful whether these fusions have any relations to those of the sporophyte with the auxiliary cells. The evacuated cystocarpic conceptacles remain empty, or become partly filled with regenerating tissue produced from above.

As mentioned above, this species grows particularly on large boulders; it is therefore probably much commoner than might be supposed from the localities given below, while it does not always become loosened from the stone by the dredge. It occurs in all the three forms quoted by FOSLIE which however, as stated by this author, are "not well defined, as transitions often appear to occur". It seems to be rather common in the Danish waters to the limits of the Baltic Sea, with the exception of the Limfjord and other fjords where it is wanting. It seems most common in the Kattegat. It occurs in depths of 2 to 19 meters. Tetrasporangia have been met with in April, carpogonia in January and May, and carpospores in May.

Localities. **Sk:** ZK¹⁰ off Lønstrup, 11,3 m; off Hirshals, 11–15 m. — **Ku:** TX, north of Græsholm (Hirsholmene); on stones picked up by Hirsholmene, about 4,5 m, large crusts; east of Deget; off

Frederikshavn; UC, TO, 18 m and FF (Trindelen) north of Læsø. — **Ke**: ZE, Fladen; IB, Store Middelfartgrund. — **Km**: XB and XC south of Kobbergrund. — **Ks**: HS, Briseis Grund; OU, Schultz's Grund; OO, Søborghoved Grund. — **Sa**: KK, Klørgrund, south of Hjelm; FT, Klepperne. — **Lb**: Middelfart. — **Sb**: Reef at Korsør harbour, 2 m; NN, south-west of Sprogø, 19 m. — **Su**: Off Aalsgaarde, 26 m (H. E. Petersen); TF³, Staffans Flak, 14–18 m. — (**Bm**: Stones picked up near Stevns ?).

8. *Lithothamnion lævigatum* Foslie.

Foslie, Norweg. Forms, 1895, p. 139, pl. 19, fig. 21–23; Heydrich, Lithoth. Helgoland, 1900, p. 76.

Lithothamnion embolooides Heydrich, Lith. Helgol., p. 74, Taf. II Fig. 15 (teste Foslie).

Phymatolithon lævigatum (Fosl.) Foslie, Remarks, 1905, p. 79.

Judging from Danish specimens, this species appears to be quite distinct from *L. polymorphum*, whereas, according to FOSLIE (Remarks, p. 79), in more southern localities there is no distinct limit between these two species. *L. lævigatum* is characterized by a comparatively thin, smooth crust, up to 0.5 mm thick, by the roof of the sporangial conceptacles disappearing after the evacuation of the sporangia, and by the two-parted sporangia. When occurring together with *L. polymorphum*, the difference between them is evident; the two species are, however, only rarely met with in the same locality, and it must be emphasized that *L. polymorphum* does not occur in the Limfjord, where *L. lævigatum* has been met with in several localities. I therefore do not doubt that they are specifically distinct.

The anatomical structure much resembles that of *L. polymorphum*. The hypothallium is similar, but is sometimes more fully developed. Its cells were found to be 13–21 μ long, 4.5–7 μ broad. The cells of the perithallium were less variable

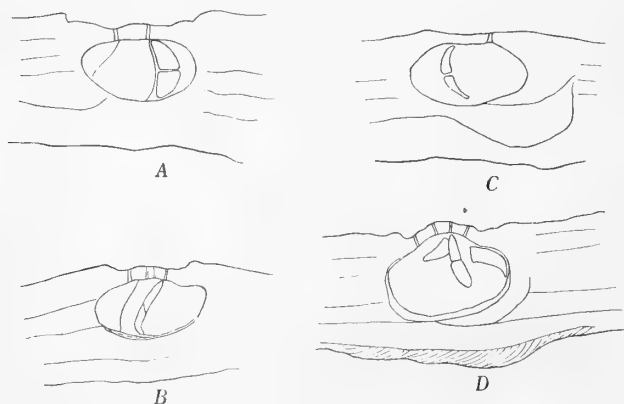


Fig. 150.

Lithothamnion lævigatum. Vertical sections of crust from Bolsaxen. **Sb**, showing sporangial conceptacles and limiting lines between the zones, fig. D also the hypothallium. 65:1.

in breadth than those of *L. polymorphum*; they were almost always 6–7 μ thick. The length was usually 6–9 μ , most frequently 7–8 μ , or only little greater than the breadth, and the rounded cells thus approach the spherical form; but cells shorter than broad are also met with (fig. 151 A). Transverse fusions occur here and there, in the hypothallium and the perithallium as well. Starch grains are frequently present as single grains in great numbers in most of the cells, except the uppermost.

Only sporangial conceptacles were met with. They resemble those of *L. polymorphum*, and the hollow containing the roof is, as in that species, sometimes very slight or wanting, and the elevated border may also be wanting, the surface over the conceptacle thus being quite even or with

only a feeble trace of deepening or elevation (fig. 150 C). The roof is sometimes convex, though inserted in the bottom of a hollow. The sporangia are, as stated by FOSLIE, always two-spored. I found them to be $95-126\ \mu$ long, $(18-37-53\ \mu)$ broad, thus a little smaller than the dimensions found by FOSLIE, which might perhaps partly be caused by the fact that my measurements have mostly been made with dehydrated sections. The conceptacles are sometimes covered by a particular tissue similar to that mentioned for *L. polymorphum* (p. 230). It has also been mentioned by HEYDRICH and FOSLIE (Remarks, p. 80). According to the first named author (l. c. p. 76) it is always present in *L. emboloides* which, as shown by FOSLIE, is identical

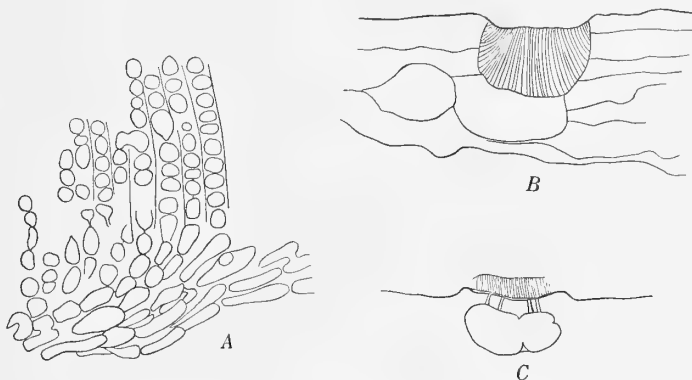


Fig. 151.

Lithothamnion lœvigatum. A, vertical section of hypothallium and the under part of perithallium. B, vertical section of crust with emptied sporangial conceptacle filled with regenerative tissue, showing the outlines of older filled conceptacles. C, vertical section of empty conceptacle with covering tissue.

A 350:1. B-C 65:1.

with *L. lœvigatum*; it is, however, not suitable for use as a specific character, for in some specimens it covers all or nearly all the conceptacles, while in others it is almost or entirely wanting. I have only seen it on emptied conceptacles which still showed muciferous canals (fig. 151 C). It has a white colour.

After the evacuation of the sporangia, the roof falls into decay. A regenerating tissue, produced from the bottom of the conceptacle, consisting of ascending filaments, may then fill the empty cavity. A new conceptacle is frequently produced at so small distance over the first one that the base of the second is situated within the limit of the first, and the new one is thus partly produced by the regenerating tissue (fig. 150, 151). Overgrown empty conceptacles do not occur.

The species occurs in depths of 2–24.5 m, most frequently 5–20 m, growing on stones and on *Mytilus* and *Ostrea*, often in company with other *Lithothamnium*, as *L. Lenormandi*, *L. glaciale* and *L. polymorphum*. It has been found growing over *L. glaciale*, and in one case on the frond of *Chondrus crispus*. It has been found with ripe sporangia in April and May.

Localities. **Ns:** aF, N.W. of Thyborøn, 31 m. — **Sk:** 4 miles N.¹/₂E. of Svinkløv beacon, 9 m (A. C. Johansen); SY off Løkken, 13 m; ZK⁶, off Lønstrup, 12 m; off Hirshals (Børgesen). — **Lf:** Salling-sund near Nykøbing (Th. Mortensen, !); LS¹, 5.5 m and aT¹, 4–5 m, east of Mors; Livø Bredning (C. H. Ostenfeld); Lendrup Røn. — **Kn:** Herthas Flak, 19–22 m; east of Deget near Frederikshavn; Trindelen, near the double broom (Børgesen). — **Ke:** IL, Fladen, 24.5 m; OO, Søborg Hoved Grund, 8.5 m. — **Ks:** RL, north of Gilleleje, 15 m; HO, N.W. of Gilleleje, 22.5 m; OS, Hastens Grund, 14 m. — **Sa:** KM, east of Øreflippen; BE, off Sletterhage; YV, east of Samsø, 15 m; north side of Refsnæs, 19 m (C. H. Ostenfeld);

DK, Bolsaxen, 13–15 m. — **Lb**: XQ, off Middelfart, north side of Lyngsodde, 19 m; north of Fæne Kalv. — **Sb**: GT, near the broom at Asnæs; GP off Halskov, 10 m; Avernakhage by Nyborg, shallow water; near Vresen, 7–9 m (Ostenfeld). — **Su**: At Ellekilde Hage 11,5 m.

Epilithon Heydrich.

Melobesiae, Ber. deut. bot. Ges. 1897, p. 408.

1. *Epilithon membranaceum* (Esper) Heydrich.

Heydrich, l. c.; Cotton, Mar. Alg. Clare Island, 1912, p. 150.

Corallina membranacea Esper, Pflanzenk. 1786 t. 12, fig. 1–4 (not seen).

Melobesia membranacea Rosanoff, Mélob., 1866, p. 66, pl. II figs. 13–16, pl. III fig. 1; Hauck, Meeresalg., p. 265; Guignard, Dével. et const. des anthéroz., Revue gén. de Botanique. I, 1889, p. 182, pl. VI figs. 22–23.

Melobesia corticiformis Kützing; Rosanoff, Mélob. p. 76, pl. I figs. 14–16; Solms, Corall. p. 11, Taf. III Fig. 25.

Lithothamnion membranaceum Foslie, List of spec. of the Lith., 1898, p. 7; Remarks, 1905, p. 72.

As to the morphology of this species reference may be made to the descriptions of ROSANOFF and FOSLIE, to which I have only little to add.

The cells of the basal layer are, as pointed out by ROSANOFF (l. c. p. 67), not arranged in distinct concentric zones; they are often connected through transversal fusions (fig. 152 A). The frond is monostromatic in its marginal part, which may be of greater or lesser extent. Otherwise the frond is often partly distromatic, and near the conceptacles it becomes gradually thicker, the cells dividing by transverse walls. There is thus no distinction between hypothallium and perithallium.

The sporangial conceptacles were often somewhat smaller than stated by FOSLIE, viz. 110–140 μ in diameter. Their outline is frequently oval, as mentioned by ROSANOFF (l. c. p. 76) and Mme LEMOINE (in COTTON, Clare Isl. Surv. p. 150). The

number of the muciferous canals was also often somewhat less than that found by FOSLIE, namely 8–27, most frequently 16–21, while FOSLIE indicates 20–30. No relation was found between the number of the muciferous canals and the locality.

The sporangia apparently arise from the second cell-layer. The

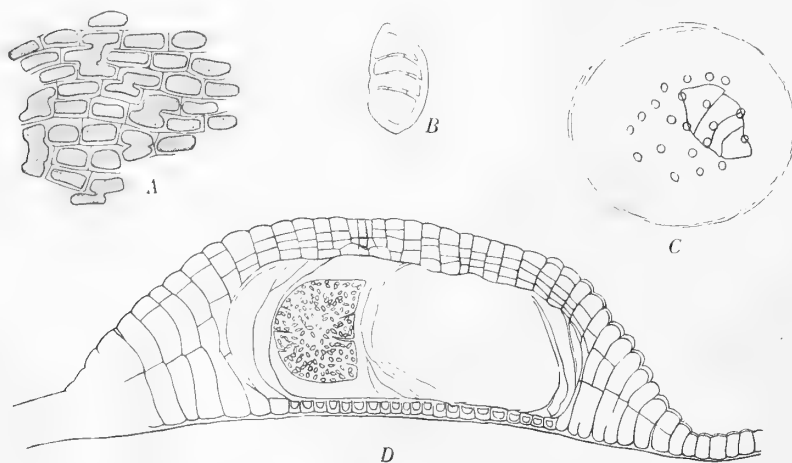


Fig. 152.

Epilithon membranaceum. A, frond seen from below showing several fusions. B, tetrasporangium not yet fully divided. C, sporangial conceptacle seen from above; a sporangium is seen under the roof. D, vertical section of sporangial conceptacle. A, B, D 345:1. C 200:1.

cells of the basal layer situated at the periphery of the conceptacle lengthen in a vertical direction, fuse laterally two or three together, and are finally disorganized, the upper part of their membrane being dissolved as far as it meets the cavity of the conceptacle. The cells of the same layer forming the central part of the floor of the conceptacle are disorganized in the same way, their contents finally disappearing, but they do not lengthen. In fig. 152 *D* the contents of these cells are still visible. In the sexual conceptacles the basal layer is exhausted in a similar way. The formation of the three dividing walls of the sporangia is almost simultaneous, the walls advancing slowly from the periphery towards the longitudinal axis of the sporangium (fig. 152 *B, D*).

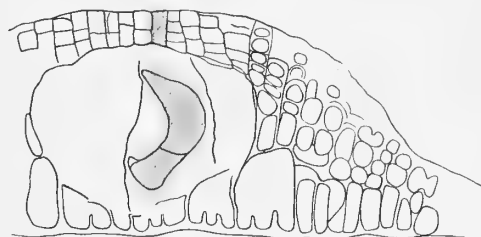


Fig. 153.

Epilithon memb anaceum, vertical, somewhat excentric section of sporangial conceptacle. 345: 1.

The antheridial conceptacles were found agreeing with the description and figure of ROSANOFF (l. c. p. 59, pl. II fig. 14). The cells surrounding the orifice are elongated and directed obliquely upwards (fig. 154). The antheridia clothe the bottom of the conceptacle; their development and structure have been followed by GUIGNARD, who found that they are seriate in densely placed short filaments. When the spermatia are to be formed, the protoplasm accumulates around the nucleus in the middle of the cell and becomes surrounded by a thin membrane, while the rest of the contents develop into two appendices, first described by ROSANOFF and named "oreillettes".

The orifice of the cystocarpic conceptacles is clothed with similar elongated, hair-shaped cells like those of the antheridial conceptacles, but more numerous; they are directed inwards or downwards in the under part, upwards in the upper part of the orifice. The carpospores are only produced at the periphery of the conceptacle; in the central part of the floor carpogonia are still visible, when the carpospores are well developed (fig. 155 *B*). As to the structure of the procarpus I

cannot give any certain statement; they seem to resemble those of *Lithothamnion polymorphum*.

The species, referred by earlier authors to the genus *Melobesia*, had been transferred by HEYDRICH in 1897 to a new genus *Epilithon*, which was re-

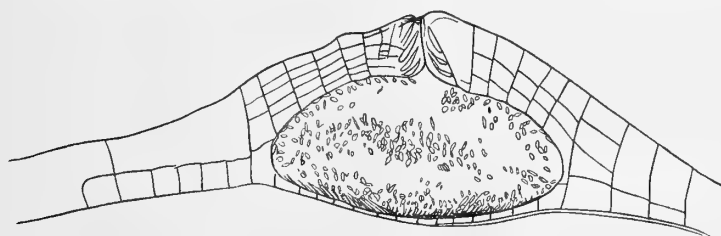


Fig. 154.

Epilithon membranaceum, vertical section of antheridial conceptacle. 500: 1.

duced in the following year by FOSLIE to a subgenus of *Lithothamnion*, with which it agrees by the fructification. The want of differentiation in hypothallium and

perithallium seems to justify the distinction of the genus *Epilithon*. Another important generic distinction seems to exist in the position and development of the antheridia, which in the genus *Lithothamnion*, as far as known, are not seriate, and always placed on a system of branched filaments filling the cavity of the conceptacle (see above pp. 213, 218).

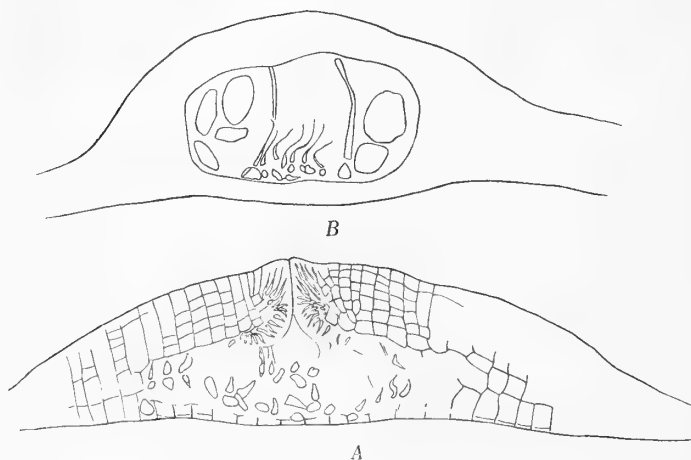


Fig. 155.

Epilithon membranaceum, vertical sections of cystocarpic conceptacles. A, showing the orifice, B, showing carpogonia at the centre and carpospores at the periphery. 350:1.

The species usually grows on *Furcellaria fastigiata*, but occurs in the Kattegat also on *Chondrus crispus*, and has likewise been met with on *Phyllophora rubens* and *Ph. membranifolia*. It is rather common in the Danish waters within Skagen to the western Baltic Sea, but does not occur in the Limfjord (and in other fjords), and in the Sound it has only been met with north of Helsingør. It has been

found in depths between 1 and 20 meters, and there is in this respect no difference between the different waters. Its absence in the Skagerak depends probably on the want of protection in this agitated water.

Localities. **Kn:** Marens Rev, Deget a. o. locality near Frederikshavn; **FF** and **FE**, Trindelen, 9—15 m; **UB** and **TG**, north of Læsø. — **Ke:** IM, Fladen, 16 m — **Km:** XB, south of Kobbergrund; **NV**, off Randers Fjord. — **Ks:** FO, Havknude Flak; **GG**, Sjællands Rev, 4 m; **D**; **EJ**, entrance to Isefjord; **RL**, near Ostindiefarer Grund, 15 m; **OO**, Søborg Hoved Grund, 8,5 m. — **Sa:** **FT**, north of Samsø, 5,5 m; **DK**, Bolsaxen; **AH** and **AH¹**, Lillegrund north of Fyens Hoved; **MQ**, south of Paludans Flak; **AY**, Ashoved. — **Lb:** **AX**, Bjørnsknude, 9,5 m; north of Fænø Kalv; **Fænø Sund**; **UX**, at the north end of Årø, 9,5 m. — **Sb:** **DN**, Vengeance Grund; **Spodsbjerg**; **DT**, off Magleby, Langeland. — **Sm:** Venegrund. — **Su:** **BQ**, off Ellekilde; off Aalsgaarde. — **Bw:** **DU**, off Dimesodde, 11,5 m; **UL**, Øjet, 20 m; **KZ**, off Kramnisse, 4,5 m.

Melobesia Lamour. emend.

The extent of the genus *Melobesia* has in course of time been repeatedly altered, certain species or groups of such having at various periods been detached therefrom and referred to new or other previously known genera. Thus in 1889, SCHMITZ removed *Melobesia Thuretii*, and gave it the name of *Choreonema Thuretii*; in 1897, *M. membranacea* was established by HEYDRICH as representative of a new genus, *Epilithon*, related to *Lithothamnion*. FOSLIE again, in 1898 (List of sp. p. 11) and 1900 (Rev. Surv. p. 21) placed *M. pustulata* and some related species under a new

genus, *Dermatolithon*, characterised by having a single apical pore in the hemispherical-conical conceptacles, sporangia "with short foot rising from the almost plain disc" and developing, according to ROSANOFF, between club-shaped (?) paraphyses. In 1904 (Algol. Not. I. p. 3) however, he comes to the conclusion that these characters had not proved sufficiently constant, and did not form any distinct limit as against the genus *Lithophyllum*. He therefore no longer maintains *Dermatolithon* as a genus, but regards it as a sub-genus under the last-named genus, to which Heydrich had already previously (Corallinaceæ etc., Ber. deut. bot. Ges. 15, 1897, p. 47) reckoned *Melobesia* *Corallinæ* Crouan, and points out that it is further distinguished by its anatomical structure, the hypothallium being formed by a single layer of inclined cells. In 1909, (Algol. Not. VI, p. 57) however, it is again reinstated as a genus, FOSLIE now attaching greater importance to the mentioned anatomical character, and it was adopted by SVEDELIUS in 1911. M. B. NICHOLS, who has subjected some species of this relationship to closer investigation, (Univ. of California Publ. in Botany vol. 3, No. 6, 1909) discusses some of the other characters cited by FOSLIE, viz: the presence of a "plug" in the orifice of the sporangial conceptacles united at the basis by a parenchymatic tap; the position of the sporangia at the bottom of the conceptacle, which in *Melobesia* is said to be almost flat, in *Lithophyllum* over-arched; and the presence of a stalk cell under each sporangium in *Melobesia*. He adopts the standpoint which Foslíe then adhered to; i. e. not maintaining *Dermatolithon* as a genus, but referring the species concerned to *Lithophyllum*, (*L. macrocarpum*, *pustulatum*, *tumidulum*). He points out, however, that in so doing, "the characters which separate *Lithophyllum* and *Melobesia* are not sufficiently well marked to warrant two separate genera" (p. 361). With regard to the structure of the conceptacles and the organs of reproduction, there is doubtless great similarity between the two genera; at any rate, no thoroughgoing differences appear to have been demonstrated up to now. The vegetative structure seems to me to present an excellent distinctive character, as in *Melobesia*, we never find transverse pits between the upright cell-series proceeding from the basal layer, whereas such are present in all *Lithophyllum* species, including the subgenus *Dermatolithon*. On the other hand, transverse fusions are of common occurrence in the *Melobesia* species, but are wanting in *Lithophyllum*. This seems, as a matter of fact, to be the best distinctive character between the two mentioned genera.

As to how far there may be reason to make further exclusions from the genus *Melobesia*, this must be left to further investigations to decide. FOSLIE, in 1900, (Rev. Surv. p. 21) established a subgenus *Heteroderma*, which he characterises as having the "thallus composed of more layers of cells" in contrast to *Eumelobesia*, which should have but one layer, except as regards the frond near the conceptacles. In 1905 however, (Remarks p. 102) a different limitation is made, and in 1909, (Alg. notes VI, p. 56) *Heteroderma* is raised to the rank of a genus, distinguished from *Melobesia* solely by the lack of hair-cells. I do not consider that we are justified in distinguishing between two genera merely by the presence or absence of hair-

cells, as the occurrence and frequency of these cells seems to depend to a great extent upon external conditions. I therefore attach but little importance to the fact that such have not hitherto been found in two of the species mentioned below (*M. minutula* and *microspora*) as it must be considered highly probably that they will be found on further investigation of a greater number of specimens. Moreover, hair-cells are found in *M. Lejolisii*, noted by FOSLIE under the genus *Heteroderma* (see fig. 156). On the other hand, I could well imagine that it may later on be found justifiable to distinguish between those species in which the trichocytes are terminal in the horizontal cell filaments, as in *M. farinosa*, for instance, and the other, doubtless far more numerous species in which they are intercalary. Another vegetative character which might be thought to furnish grounds for generic distinction, is the lack of cortical cells shown below in the case of *M. microspora*. This point, however, still needs further investigation. As regards the cortical cells, it may also here be noted that in *M. trichostoma*, several of these were found above one another, cut off successively by the same frond cell.

Where the frond consists of more than one cell-layer, there is often but slight difference between the basal layer (hypothallium) and the upright cell filaments proceeding therefrom (perithallium). Thus the walls forming the boundary between these two tissues often lie at different heights, as for instance in *M. microspora* (figs. 176—179) and *M. trichostoma* (174—175).

The number of spores in the sporangia is in most of the present species constant. In four species, 4 spores were found, in *M. subplana* a constant 2. In *M. minutula* only specimens with 4 spores were found, whereas FOSLIE gives 2, and in *M. Fosliei* some conceptacles were found with 4, others with 2 spores in the sporangia. — A small stalk-cell under the sporangium was found in *M. subplana*.

With regard to the antheridia, *M. Lejolisii* was found to differ from the other species in having the spermatangia formed at the end of long sterigmata, as first shown by Mrs. WEBER-VAN BOSSE. In the other species, the spermatangia are elongated cells, situate on the flat bottom of the antheridia-conceptacles. The orifice of the antheridia-conceptacles was in four of the present species often found drawn out into a spout, as first shown by Mrs. Weber-van Bosse in the case of *M. Lejolisii*. This is, however, not a constant character, as it may frequently be lacking in all the species concerned.

The carpospores are in all the cases investigated formed only in the periphery of the conceptacle, at the margin of the flat disc-cell.

1. *Melobesia Lejolisii* Rosanoff.

Rosanoff, Rech. anat., 1866, p. 62, pl. I fig. 1—13, pl. VII fig. 9—11; Areschoug, Observ. phycolog. Part. III, 1875, p. 3; Hauck, Meeresalg., p. 264; A. Weber-van Bosse, Bijdrage tot de Algenflora van Nederland, Nederl. kruidk. archief. 2. Ser. 4. deel 4e stuk, Nijmegen 1886, p. 365; ead. in Hauck et Richter, Phykotheke univers. No. 163; Foslie, Remarks, 1905 (1906) p. 102 (f. *typica*); Mme P. Lemoine, Struct., p. 180, fig. 103; ead., Calcareous Algæ in Report on the Danish Oceanogr. Exped. 1908—10 to the Mediterranean etc. Vol. II, 1915, p. 19.

Among the distinctive characters of this species, used by ROSANOFF, in his important paper on the Melobesiaceæ, the want of "heterocysts" has been of special importance in distinguishing it from *M. farinosa*, as it permitted determination even in cases where the characters taken from the organs of reproduction could not be used. As shown by FOSLIE however, l. c. p. 103, the cells situated under the dichotomies are often larger than the others and resemble the heterocysts of *M. farinosa*. I can confirm Foslies' statement, having frequently found these cells in Danish specimens of *M. Lejolisii*.

They agree indeed completely with the heterocysts of *M. farinosa*, in bearing a hair or a scar left by a shed hair, in being poorer in contents and in bearing no cortical cells as do the other cells of the monostromatic frond. But they differ from the heterocysts of the last-named species in being derived, not from end-cells of filaments, which do not develop further, but from cells situated under

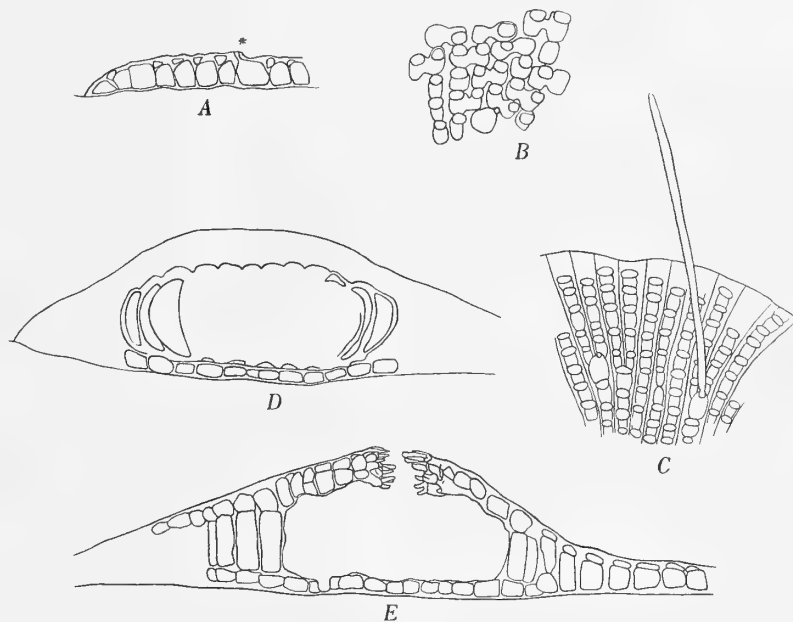


Fig. 156.

Melobesia Lejolisii, from Birkholm, Sf. A, vertical section of marginal part of frond, * trichocyte. B, monostromatic frond seen from above; below a trichocyte, numerous fusions. C, marginal part of frond seen from above; two trichocytes are visible, one with hair. D, vertical section, not median, through a sporangial conceptacle; only undivided sporangia present. E, vertical section through emptied sporangial conceptacle. 350:1.

a ramification. I have convinced myself that this difference really exists by examining authentic specimens of *M. farinosa*. Where the included heterocysts of this species are present it is easily seen that the two cell-rows, the separating line of which goes in continuation of the heterocyst, are not given off from this, but from the adjacent cell-rows. As shown by SOLMS (Cor. p. 24), these cells produce a hair without formation of a transverse wall. The hairs are, according to the mentioned author, very short-lived, and fall off after a separation has taken place at their base by local incrustation of the longitudinal wall. This is also the case with those of *M. Lejolisii*; sometimes, however, they are more persistent, and appear as long hyaline hairs (fig. 156 C). Their wall is stained very intensely by hæmatoxyline, by which they become very obvious, and the same is the case with the basal part

of the cell, after the throwing off of the hair. As these cells are very different from the heterocysts of the *Cyanophyceæ*, I think it better to give them another denomination; they must be named hair-cells or trichocytes (comp. p. 213). They are somewhat larger than the other cells. Sometimes also, other intercalary cells than the branch-producing ones may develop into a trichocyte, and it may also happen that a trichocyte produces a cortical cell. These cells appear to be of normal occurrence, though varying in number¹.

In the monostromatic part of the crust the cells are 7–10(11) μ broad, and usually 1–1½ times as long. The dimensions are somewhat variable (comp. figs. 156 and 158). In specimens from the inner Danish waters (Sf and Sm) the breadth

of the cells was only 7–9 μ , in specimens from Lf and Kn it was up to 11 μ ; this is possibly caused by the difference in salinity of the water. These cells often contain numerous starch grains, but the trichocytes contain no starch. The cortical cells are always longer in transversal than in radial direction. Transversal fusions between the cells may occur, sometimes in great number (fig. 156 B). In a vertical radial section the cells are seen to be of about the same height as breadth.

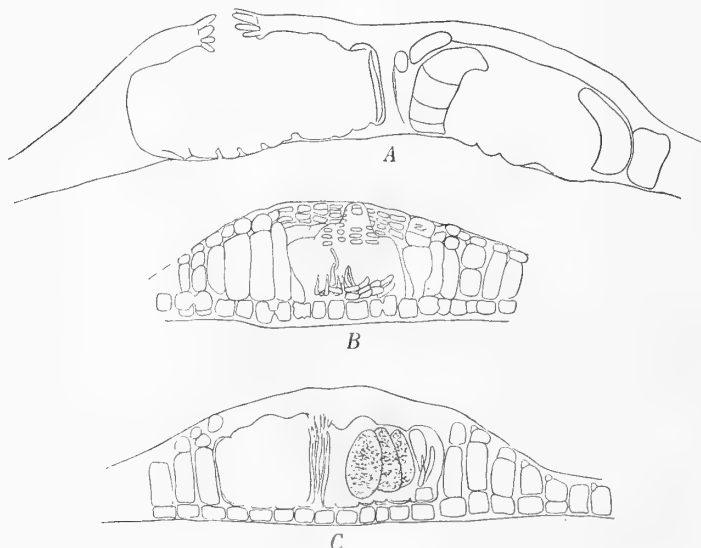


Fig. 157.

Melobesia Lejolisii. Vertical sections of conceptacles. A, from Stensuæs, Km, sporangial conceptacles. B and C from Kragenæs, Sm; B, with carpospores, C, with undivided sporangia, in the middle a columella. 350:1.

The marginal part of the frond remains monostromatic, the small cortical cells not taken into account. Only in the immediate vicinity of the conceptacles the frond consists of 2–3(4) layers of cells. As the conceptacles are densely placed in the greater inner part of the crust, the frond is monostromatic only in the marginal part. The statement of Mme LEMOINE (Structure, p. 180, fig. 103) that the crust of

¹ The trichocytes appear to be variable in their occurrence also in *M. farinosa*. In specimens from LE JOLIS, Alg. mar. de Cherbourg no. 194, which, as shown by FOSLIE, is a typical *M. farinosa*, I found the characteristic trichocytes quite in accordance with the descriptions of ROSANOFF and SOLMS. On the other hand, in the *Melobesia* communicated in Crouan's Exsicc. no. 244, which indeed is referred to *M. Lejolisii* by FOSLIE, I did not find any heterocysts at all. This alga agrees, however, otherwise with *M. farinosa*, by the dimensions of the cells (11–14 μ broad, about 1½–2 times as long) and by the round, not transversely elongated cortical cells. I suppose therefore that it is a form of *M. farinosa*, in which no trichocytes have been developed.

this species consists of three cell-layers, the middlemost of which is composed of high cells, must refer to the fertile part of the crust (comp. fig. 159 *D*); but the author says that she has observed three layers also at a great distance from the conceptacles. Possibly, the specimens referred to this species by Mme LEMOINE do not all belong to it. In *Calc. Alg. Med.*, 1915, p. 19, the same author mentions specimens of this species from the Mediterranean consisting only of two layers of cells, the upper being the cortical cells; these specimens thus agree with the Danish ones.

The conceptacles of sporangia are usually densely crowded. They are low conical or, when very densely placed, depressed, with almost level surface (figs. 156—158). The orifice is rather narrow, almost cylindrical, not enlarged upwards, clothed with unicellular hairs of varying length. In rare cases I found the hairs long and protruding outwards in a vertical direction (fig. 158 *D*), as drawn by ROSANOFF in fig. 11, pl. I, l. c., but usually they are shorter, directed inwards horizontally and not protruding (figs. 156 *E*, 157 *A*, comp. ROSANOFF's

fig. 8). The last quoted figure of ROSANOFF certainly represents a normal, fully developed state. FOSLIE, who did not find any protruding crown at all in examining numerous specimens, thought that this might perhaps be owing to the fact that he had only had dried material for examination, "or it may be that the cells of the corona have a short phase of development and are soon falling to decay". My investigations do not favour these suppositions; it must be supposed, that the development of the hairs is variable according to the various conditions. — The roof of the conceptacle is rather thin, consisting of about 2 (1—3) cell-layers, only a little thicker, if at all, near the orifice. The floor of the conceptacle consists of a single cell-layer; more rarely this cell-layer is absorbed (fig. 157 *A*). In some cases a sterile columella was observed in the centre of the conceptacle (fig. 157 *C*), but

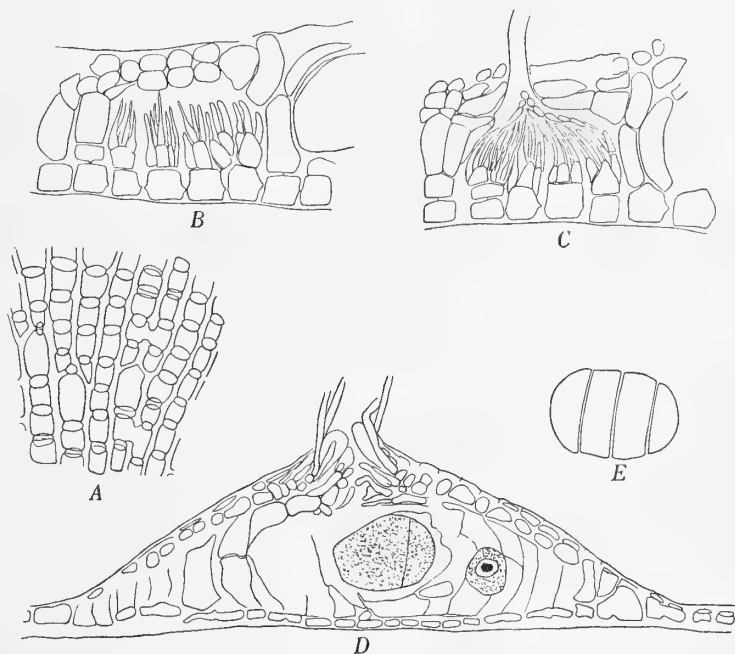


Fig. 158.

Melobesia Lejolistii, from TG, north of Læsø. *A*, frond seen from above, at left a trichocyte. *B*, vertical section of antheridial conceptacle, not yet ripe. *C*, vertical section of antheridial conceptacle provided with a spout. *D*, vertical section of sporangial conceptacle with well developed peristomial hairs. *E*, the same sporangium as seen in *D*, from a following section. *B* and *C* 650:1, the rest 350:1.

usually no such formation was to be seen. The sporangia are, when fully developed, four-parted, $45\text{--}77\ \mu$ long, $32\text{--}49\ \mu$ broad. While at first vertically placed, they may sometimes finally become horizontal, at all events when the conceptacle contains only one or two developed sporangia (fig. 158 D—E).

The antheridial conceptacles are small, often very small, and but little prominent if at all. As shown by Mrs. WEBER-VAN BOSSE (l. c.), the spermatia are produced at the end of long sterigmata developed from a layer of very small cells covering the basal layer (fig. 159 A, C). In some cases, however, the cells producing

the sterigmata are not placed directly on the basal layer (fig. 158 B, C). In some cases the conceptacle was found provided with a long slightly curved spout agreeing exactly with that described by Mrs. WEBER (fig. 158 C); but in most cases no such spout was to be seen. The ostiole was then

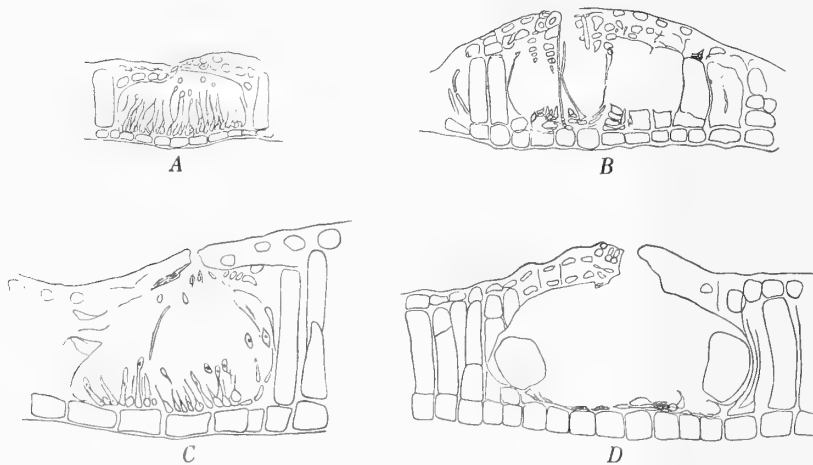


Fig. 159.

Melobesia Lejolisii. A and B from Holbæk Fjord, A, antheridial conceptacle, B, female conceptacle, showing carpogonia. C, antheridial conceptacle. D, cystocarpic conceptacle, C 650:1, the rest 350:1.

a simple small hole without any peristome. The spermatia appeared sometimes as slightly elongated cells with pointed ends (fig. 159 C).

Well developed female conceptacles were only rarely found. The conceptacles shown in figs. 157 B and 159 B are certainly female ones, containing unfertilized carpogonia, and fig. 159 D represents a cystocarpic conceptacle with the carpospores placed at the periphery only. A disc-cell could not be distinguished. Peristomial hairs seem not to be developed. The diameter of female conceptacles was found to be $123\text{--}175\ \mu$.

Ripe tetrasporangia have been found in summer (June to September), antheridia in May and September, and cystocarps (with few spores) in May.

I have referred to this species all the specimens growing on old *Zostera*-leaves and referred by FOSLIE to *M. Lejolisii* f. *typica*, with the exception of one sample mentioned below under *M. subplana*. The species has also been found growing on *Ruppia*. The specimens growing on Algæ, on the other hand, seem to belong to other species, which are mentioned below. The species has been found in depths of 1—11 meters.

Localities. **Lf**: Thyborøn; Nykøbing; LQ, Lendrup Røn; MK, Holmtunge Hage; F, Lunde Hage; ML, Gjels Bredning; stone reef west of Draget; Hals. — **Ku**: TP, Tønneberg Banke; TG, near Syrodde Pynt. — **Km**: BO, Stensnæs; EZ and XC, south of Læsø. — **Ks**: NL, Isefjord; Lammefjord; Holbæk Fjord. — **Sa**: Besser Rev, Samsø, partly on Ruppia; MT, Horsens Fjord; Odense Fjord (C. Rosenberg). — **Sf**: Nakkebølle Fjord; Svendborg; U, Birkholm; EA, north of Rudkøbing. — **Sb**: Munkebo, Kertinge Nor; Avernakhage by Nyborg. — **Sm**: CM, Kragenæs; CO; CR, off Dyrefoden; Guldborgsund.

2. *Melobesia subplana* sp. nov.

Crusta orbicularis, 1—2 mm diametro, in statu adulto non nisi margine angusto monostromatico, ceterum 2—6 cellulis crassa, cellulis in parte marginali c. 7—8 μ latis, cellulis corticalibus rotundatis, in sensu radiali paulo elongatis, trichocytis intercalaribus. Fila verticalia partis frondis crassioris cellulis longitudine vario, 6—9 μ crassis constituta. Conceptacula sporangifera dense posita, paulo prominula, diametro externo c. 150—200 μ , interno 70—105 μ ; sub conceptaculis 1—2 strata cellularum vegetativarum; tectum subplanum, c. 2—3 cellulis crassum, ostiolo cellulis paulo horizontaliter elongatis, non erumpentibus, vestito. Columella centralis conica. Sporangia 42—60 μ longa, 26—32 μ lata, semper disporica. Conceptacula mascula parva, immersa, nonnunquam tubo longo prorumpente munita, fundo cellulis spermatogenis numerosis elongatis, leniter curvatis, e strato cellularum rotundatarum egredientibus, vestito, spermatidis longis, clavatis, leniter curvatis, c. 11 μ longis, c. 2 μ crassis. Sub conceptaculis masculis 1—3 strata cellularum vegetativarum. Conceptacula feminea parva, immersa, initio non prominula, stratis cellularum vegetativarum 1—3 suffulta. Cystocarpia non certe cognita.

The specimens which have served as base for this new species were collected near Horsens at the east coast of Jutland, growing on *Zostera*-leaves. They have been determined as *M. Lejolisii typica* by FOSLIE, and certainly resemble this species very much; they differ however so much from it in some respects that I have thought better to regard it as a distinct species.

The frond is polystromatic with the exception of a narrow marginal zone. It consists otherwise of vertical cell-rows composed of 2 to 5 cells, not including the small cortical cells, which are cut off by oblique walls. Near the border, the cortical cells are seen to be rounded, narrow, usually a little lengthened in a radial sense, sometimes placed not over the anterior border but over the middle of the cell (fig. 160 A). Hyaline hairs are sometimes numerous, given off from cells without cortical cells, also from the polystromatical part of the frond. The cells of the vertical cell-rows are of varying length. There is less contrast between the basal layer and the perithallium than in *M. Lejolisii*, the upper wall of the cells of the former falling not always at the same level, the cells thus being of somewhat varying height. While in *M. Lejolisii* the intermedial layer in thicker crusts consists only of one layer of long cells, it is in *M. subplana* usually 2—4 cells thick, its cells varying from 1 to 3 diameters in height, shorter and longer cells alternating irregularly, and the transversal walls falling at different levels in the different filaments.

Transversal pores do not occur, but transverse fusions frequently take place, most frequently in the basal layer, but also between cells at a higher level. Abundant starch-grains occur in the ordinary vegetative cells.

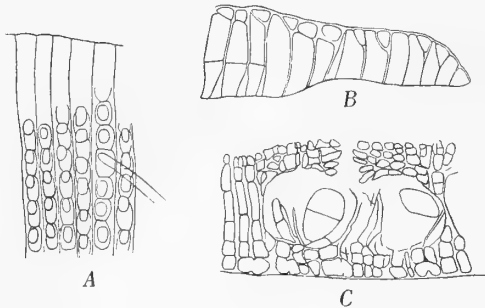


Fig. 160.

Melobesia subplana. A, marginal part of frond seen from the face. B, vertical section of border of frond. C, vertical section of sporangial conceptacle. A and B 350:1. C 200:1.

occupied by a conical columella of sterile cells, while the sporangia are placed in the outer part of the conceptacle. A little stalk-cell was frequently seen under each sporangium. The sporangia are always two-celled. I have seen numbers of them, some preserved in alcohol, and can assert that they were really two-celled, also at maturity.

I have seen only one or two male plants containing some antheridial conceptacles. These are small, completely immersed. The bottom of the conceptacle is covered by a layer of small, somewhat rounded cells, from which are given off numerous elongated slightly curved spermatia-producing cells a little incrassated upwards. I have not been able to follow the development of the spermatia, but I do not doubt that the elongated cells in question are the spermatangia, which produce long clavate, slightly curved spermatia (fig. 161). The spermatia are not formed at the end of long thin

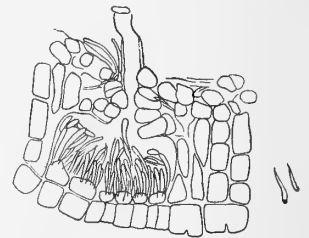


Fig. 161.

Melobesia subplana. Vertical section of antheridial conceptacle, at right presumed spermatia. 560:1.

sterigmata. The ostiole of the conceptacle was in some cases provided with a long spout resembling that of *M. Lejolisii* (fig. 161), in other cases no such spout was present.

Very few conceptacles with carpogonia were seen. They were small, not prominent; the ostiole seems to be provided with a peristome similar to that of the sporangial conceptacles. Fig. 162 B shows fully developed carpogonia with long

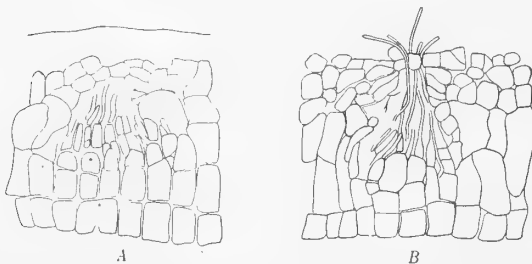


Fig. 162.

Melobesia subplana. Vertical sections of carpogonial conceptacles. A with young, B with fully developed carpogonia. B, 485:1. B 420:1.

trichogynes penetrating through the ostiole. As to the structure of the procarps, my observations are so incomplete that I must content myself with referring to the figures without any interpretation. The bottom under the female conceptacles was composed of one to three layers of cells. Ripe cystocarps in good condition were not met with; they seem to be rather similar the tetrasporangial conceptacles.

As will be seen from the above description, this species differs from *M. Lejolisii* principally by the structure of the polystromatic frond, by the shape of the sporangial conceptacles, by the normal presence of a columella, by the two-spored sporangia, and seemingly by the formation and shape of the spermatia.

Locality. **Sa:** On *Zostera*-leaves at Horsens, September 1893.

3. *Melobesia limitata* (Foslie) K. Rosenv. sp. nov.

Melobesia Lejolisii Rosanoff f. *limitata* Fosl., Remarks 1905 (1906) p. 102.

In his valuable paper on the northern Lithothamnina (Remarks, 1905 (1906) p. 102) FOSLIE described a forma *limitata* of *Melobesia Lejolisii*, characterized principally by smoother and apparently more solid crusts, and by less crowded conceptacles, frequently a little higher and somewhat pointed or subhemispherical-conical, and more sharply defined. He referred to it almost all the Danish specimens noted under the species mentioned but growing on Algæ instead of on *Zostera*. In examining these specimens, I have found that they not only differ in the characters named by FOSLIE, but that they must be regarded as representing another species distinct also in several other characters.

The crusts have a diameter of 3–4 mm, sometimes they reach 5 mm or more. They are more or less irregularly orbicular with lobed margin. Frequently several crusts are confluent. The frond may be monostromatic from the border to the conceptacles, or the inner part may be distromatic (figs. 166, 167) or even thicker (fig. 163 D). When seen from the face, the frond presents a similar aspect to *M. Lejolisii*, but the cells are usually somewhat longer, viz. (7–)8–10, 5(–12) μ broad, $1\frac{1}{2}$ to 2 times longer than broad. Transversal fusions sometimes occur. The cortical cells are longer in transversal than in radial direction. Trichocytes usually occur; they may be cells situated under a ramification or ordinary intercalary cells in the radiating filaments. They usually lack cortical cells, but such may occasionally be produced (fig. 163 A at left).

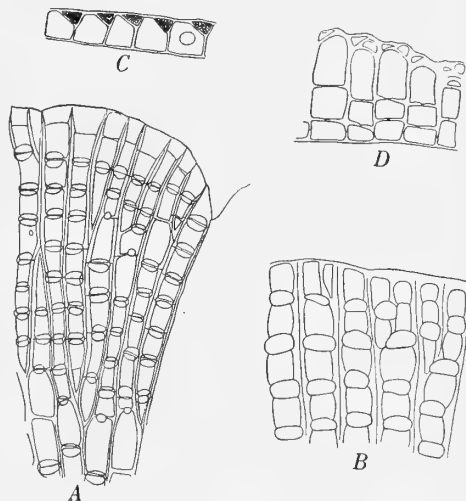


Fig. 163.

Melobesia limitata. A–B, marginal parts of frond, seen from the face, from M; A, before, B, after decalcification and staining. C and D, vertical sections of fronds, from I, D from the central part 350:1.

The conceptacles are scattered, usually not contiguous.

The sporangial conceptacles are conical or subhemispherical-conical, (170—)230—325 μ in diameter. The outer wall (the roof) is thicker than in *M. Lejolisii*, it is

3—5 cells thick and has its greatest thickness near the ostiole. It consists here of very distinct cell-filaments radiating inwards and upwards. The longest of these filaments are those directed towards the upper border of the ostiole, and which sometimes project as a crown

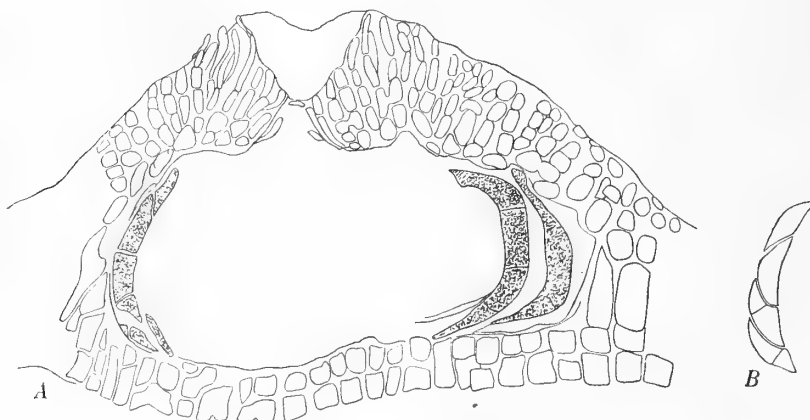


Fig. 164.

Melobesia limitata from MH. A, vertical section of nearly emptied sporangial conceptacle. B, sporangium divided into more than four cells. 350:1.

beyond the border of the ostiole. The filaments forming the crown are given off not only from the inner face of the canal, as in *M. Lejolisii*, but also from the outer surface (fig. 165). In other cases, however, the filaments do not extend beyond the border of the ostiole and a crown is thus not developed. The ostiole has usually a constriction almost in or under the middle, and over this the ostiole is funnel-shaped or barrel-shaped, according to the development of the upper peristomial filaments (figs. 164, 165).

This space is filled with a hyaline jelly. The converging filaments are easily observed when viewing the conceptacle from above. The bottom under the conceptacle consists of one or two layers of cells. The sporangia seem to be produced only in the peripheral part of the conceptacle, but there is no columella. The sporangia are four-parted, 46—77 μ long, 21—46(—61) μ broad. Un-

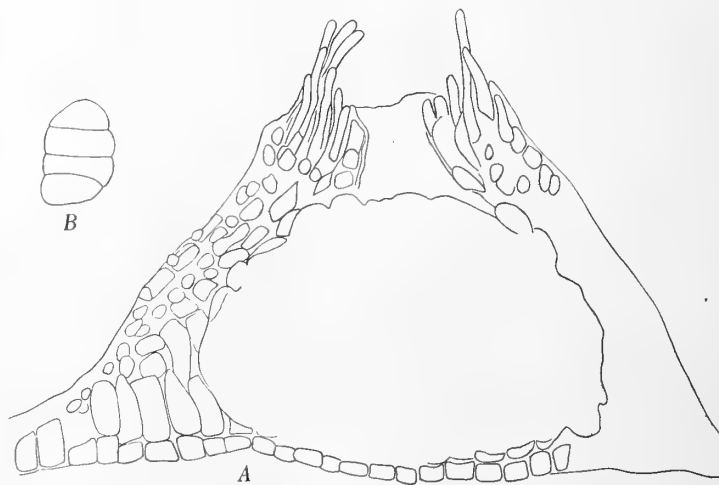


Fig. 165.

Melobesia limitata A, vertical section of sporangial conceptacle with well developed crown. 350:1. B, sporangium. 200:1.

divided and two-parted sporangia were frequently met with. In a specimen from the Limfjord, sporangia were found which were irregularly divided into more than 4 cells (fig. 164 B).

The antheridial conceptacles (fig. 166) occur in the same plants as the female ones. They are very small, e. g. $56\ \mu$ in inner diameter, totally immersed or only little prominent. The bottom is composed of one to two cell-layers. The cells of the roof are often partly disorganized. The ostiole is conical or conical-cylindrical, sometimes, but not always provided with a long spout resembling that in *M. Lejolisii*. The spermatangia are cylindrical and form a dense covering on the flat bottom of the conceptacle; they are produced from low cells forming a layer over the bottom. The spermatangia seem to be oblong, 2–3 times as long as broad. There are no long sterigmata as in *M. Lejolisii*.

The female conceptacles resemble the sporangial ones. A

young stage with unfertilized carpogonia is shown in fig. 167 A; a number of carpogonial branches are placed on the bottom. The short cell under the carpogonium is probably the auxiliary cell. After fertilization, the surrounding elongated cells shown in fig. 167 A are dissolved, the developing cystocarp increasing at the periphery. A ripe cystocarp is seen in fig. 167 D, showing a number of carpospores produced at the periphery of the cystocarp, while numerous unfertilized carpogonia are still visible on the middlemost part of the floor. The cystocarpic conceptacles are $210\text{--}325\ \mu$ in diameter; they are of the same shape as the sporangial ones, and the roof and the ostiole have a similar structure. The ostiole is surrounded by similar inward and upward converging filaments, which may sometimes project outwards as a crown. A well developed crown is shown in fig. 167 C, where the free ends of the filaments are distinctly articulated. In fig. 167 D, which shows another conceptacle of the same plant, the free ends of the filaments seem to have been thrown off, for the converging filaments are only one- or two-celled, and re-

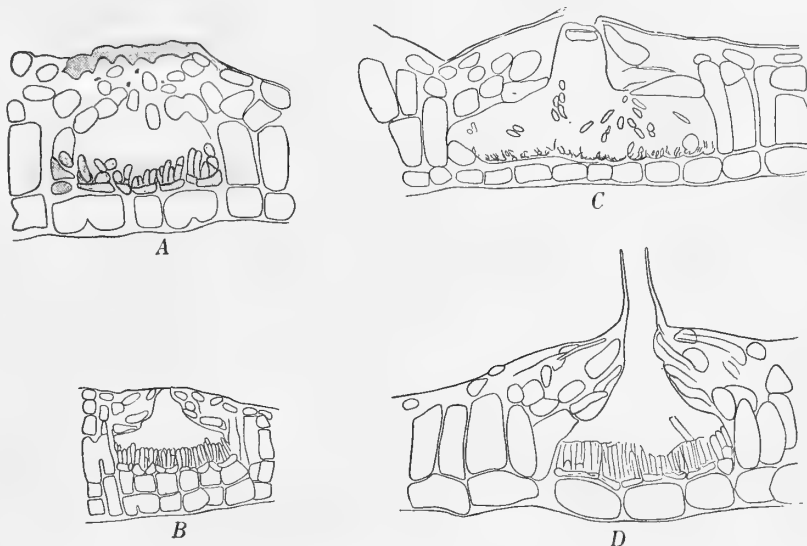


Fig. 166.

Melobesia limitata. Vertical sections of antheridial conceptacles. A–C from I, D from Amtoft Rev. A and B, before discharge of the spermatia. D, the ostiole is prolonged in a spout. A and D 650:1. C 560:1.

mains of the free ends of the filaments are still visible at the border of the ostiole. On the other hand it is certain that a crown is not always developed, for ripe and emptied cystocarpic conceptacles may be found in which the structure of the ostiole

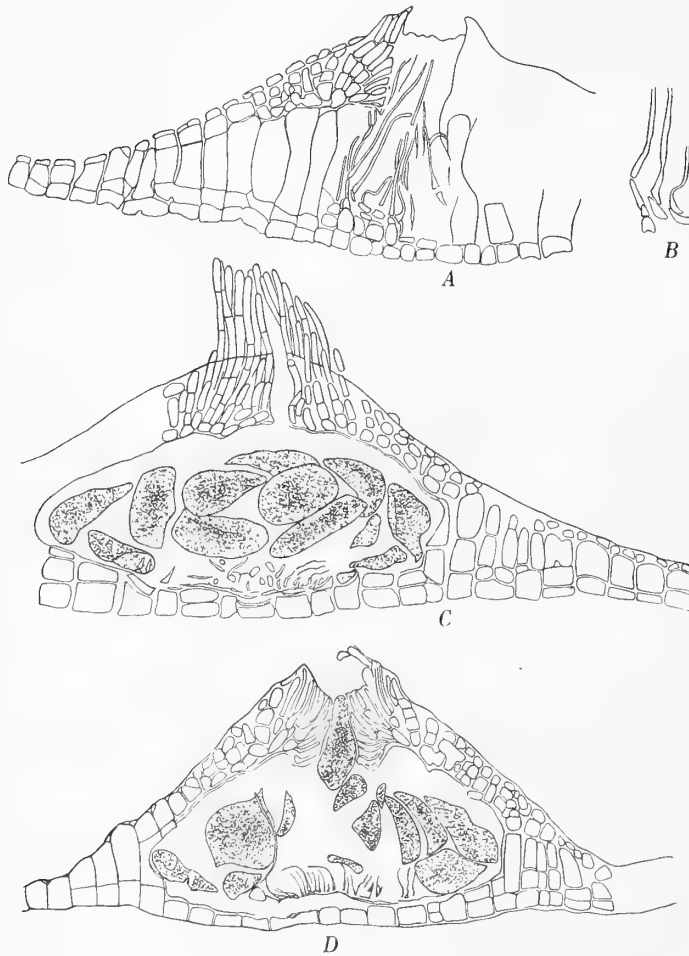


Fig. 167.

Melobesia limitata. Vertical sections of female conceptacles. A, young stage with unfertilized carpogonia. B, fully developed cystocarpic conceptacle with well developed crown consisting of articulated filaments. C, fully developed cystocarpic conceptacle in the stage of emptying; the crown has perhaps been thrown off. From Amtoft Rev. A, C, D 350:1. B 650:1.

described above, thus different from those of *M. farinosa*, in which they are terminal.

All the specimens referred to this species were growing on Algæ, particularly on *Fucus vesiculosus*, thus all the specimens found in the Limfjord, otherwise on *Chondrus crispus*, *Rhodymenia palmata* and *Laminaria digitata*. In the Limfjord it was always found growing together with *Lithophyllum macrocarpum*. Sporangia, antheridia and cystocarps were met with in August and September. The species is certainly annual.

agrees exactly with that of the young conceptacles shown in fig. 167 A, and which show no trace of a shed crown.

As will be seen from the above, this species differs from *M. Lejolisii*, besides the characters named by FOSLIE, principally by the thicker roof of the sporangial and cystocarpic conceptacles, and by the central part of the roof consisting of long converging articulated filaments, sometimes projecting outwards as a crown, and further by the structure of the antheridial conceptacles, the spermatia being not produced at the end of long sterigmata.

I refer to this species the specimens from Nykøbing, Mors referred by FOSLIE with doubt to *Melobesia farinosa* f. *borealis* (Foslie, Remarks, p. 98). Foslie did not find any heterocysts, but I found some intercalary trichocytes with or without cortical cells, as

Localities. **Lf:** Søndre Røn by Lemvig; Thisted; off Skrandrup and off Hanklit, Thisted Bredning; Venø Bugt off Nørreskov; Nykøbing; Amtøft Rev and LQ, Lendrup Røn in Løgstør Bredning. — **Kn:** Deget by Frederikshavn, on *Chondrus crispus*; Nordre Rønner; UB, north of Læsø; Trindelen, on *Rhodymenia palmata*, 19 meters. — **Sa:** AY, off Ashoved, on *Laminaria digitata*, 10 meters.

4. *Melobesia Fosliei* sp. n.

Frons minuta ambitu irregulari, monostromatica vel prope conceptacula polystromatica. Cellulæ partis monostromaticæ (6—)7—9(—11) μ latæ, diametro æquilongæ vel ad sesqui longiores; cellulæ corticales parvæ, ellipticæ. Trichocyti plerumque adsunt. Conceptacula sporangifera hemisphærica vel subhemisphærica, diametro 80—140—185 μ , dum dense posita confluentia. Tectum 1—2 cellulis crassum. Cellulæ ostiolum circumdantes a ceteris paulo diversæ, nonnunquam ostiolum versus paulo elongatæ, vel papillas horizontales formantes. Ostiolum interdum in rostrum breve protractum. Sporangia quadripartita et bipartita, 42—60 μ longa, 18—30 μ lata. Conceptacula mascula parva immersa, paulo prominentia; spermatia lineari-clavata, leniter curvata in fundo conceptaculi gignuntur. Conceptacula feminea eadem forma et structura ac conceptacula sporangifera.

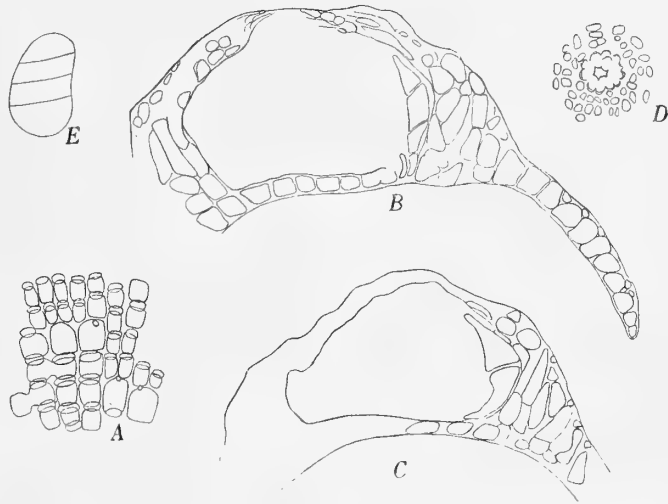


Fig. 168.

Melobesia Fosliei. A—C, from Deget. A, monostromatic frond seen from above. B, vertical section of a sporangial conceptacle showing one four-parted sporangium. C, vertical section of sporangial conceptacle showing one two-parted sporangium. The orifice has not been hit by the section. D—E from Hirsholmene. D, orifice of sporangial conceptacle seen from above. E, tetrasporangium. 350:1.

The specimens referred to this species were found growing on the fronds of *Polysiphonia nigrescens*, *Corallina rubens*, *C. officinalis* and on Bryozoans living in company with these Algæ. They are rather variable in several respects, but as the differences are met with not only between specimens growing on different substrata, but also in specimens growing on the same alga, I do not hesitate in referring them all to the same species.

Most of the specimens were found growing on *Corallina rubens*; these specimens may first be mentioned here. The structure of the monostromatic frond much resembles that of *M. Lejolisii*, except that the lateral walls seem to be thinner (less incrusted?). Lateral fusions are frequent. Trichocytes were usually present, situated at the offspring of ramifications, but in some cases they were searched for in vain.

The conceptacles of sporangia are proportionally higher than in *M. Lejolisii*, hemispherical or subhemispherical,

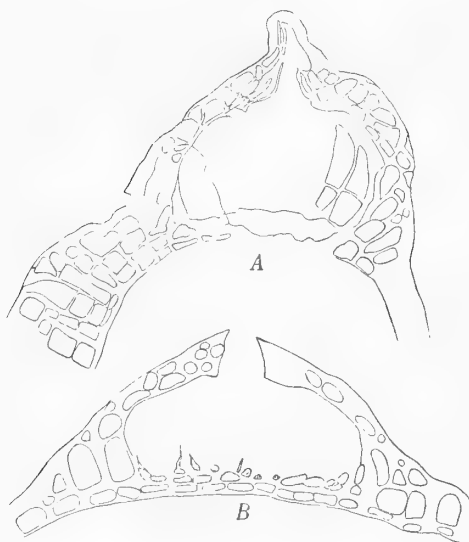


Fig. 169.

Melobesia Fosliei, from Tønneberg Banke. A, vertical section of sporangial conceptacle with orifice prolonged in a spout. B, vertical section of cystocarpic conceptacle. A 350:1. B 560:1.

are proportionally higher than in *M. Lejolisii*, the height being frequently the half of the breadth. The cells surrounding the ostiole are usually little characteristic, forming no real peristome; they may be somewhat lengthened towards the opening, but take, as it seems, scarcely the form of papillæ, and do not as a rule protrude outside the ostiolum. In some cases, however, they are elongated, going out in a prolongation of the surroundings of the ostiole in a short spout, resembling that of the antheridial conceptacles of *M. Lejolisii* and *M. limitata*, but thicker (fig. 169 A). This character, however, is not constant, being met with only in some of the conceptacles but wanting in others, usually most. When seen from above, the ostiolum appears sometimes surrounded by a rosette consisting, as it seems, of very low papillæ (fig. 168 D), in other cases no such structure is to be seen. 4-parted sporangia were found in all the specimens examined, but 2-parted ones of the same size were found in the same specimens. As I have

examined only dry specimens in which, as is well known, most of the sporangia have been emptied by the desiccation, it could not be stated whether the 2-parted sporangia were fully developed or not. I am inclined to suppose that 4-parted and 2-parted sporangia normally occur simultaneously.

The antheridial conceptacles were usually not well preserved in the dried material, but it could be seen that the spermatia were not produced at the end of long sterigmata as in *M. Lejolisii*. In one case the ostiole was found prolonged in a spout.

The conceptacles of cystocarpia were smaller than those of sporangia, and a little lower in relation to their breadth; the ostiole was similar in structure to these.

The specimens growing on *Polysiphonia nigrescens* agree in all essential points with the others; the cells of the monostromatic frond were only a little broader, 9–13 μ . A number of the conceptacles were provided with a well developed spout, containing elongated cells, the rest were without any projection. It appeared

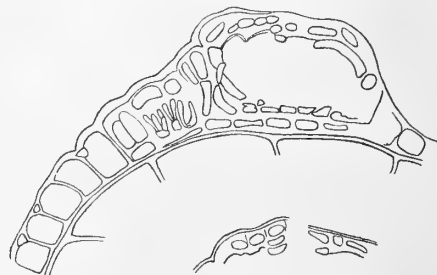


Fig. 170.

Melobesia Fosliei, from Bragerne. Vertical section of frond with antheridial and cystocarpic conceptacle. Below another section of the latter showing the orifice. 560:1.

to me that some of the first were cystocarpic ones. As shown in fig. 170 the antheridial conceptacles occur in the same fronds as the cystocarpic ones. The latter were rather small in these specimens.

The specimens growing on *Corallina officinalis*, collected north of Læsø (ZC¹, 7658a, fig. 171), are more vigorous than the specimens previously mentioned. The structure of the frond is the same, but the conceptacles reach greater dimensions. They may be hemispherical, 160–185 μ in diameter, or they may be lower, frequently fusing together, when the conceptacles are densely placed. The ostiole was provided with small papillæ directed inwards in the conical space of the orifice.

When seen from above, the ostiole appeared surrounded by a rosette exactly like that shown in fig. 168 D. The remains of a columella were found in the case represented in fig. 171 A. The sporangia were always

tetrasporic, 44–50 μ long, 11–16 μ broad.

— The antheridial conceptacles are slightly prominent; the spermatangia are produced on the flat bottom of the conceptacle from small cup-shaped cells; they (or the spermatia) are linear-clavate, slightly curved, measuring 7 μ in length, about 2 μ in their broader end. — The cystocarpic conceptacles have the same shape and size as the sporangial ones and are, as those, provided with short horizontal papillæ in the ostiole, principally in its under part.

I have been much in doubt in determining the specimens referred to this species. Some of them, those from Bragerne, Skagerak, have been referred to *M. Lejolisii* by FOSLIE (Remarks, p. 106) and I have also been much inclined to consider them as a more or less reduced form of this species. However, I have judged it better to describe it as a new species, considering, besides other characters, especially the higher conceptacles of sporangia, the formation of the spermatia taking place in our species at the bottom of the conceptacle from short cells, while in *M. Lejolisii* they are produced at the end of long sterigmata, and the long curved spermatia, while those of *M. Lejolisii* are much shorter. The antheridial concep-

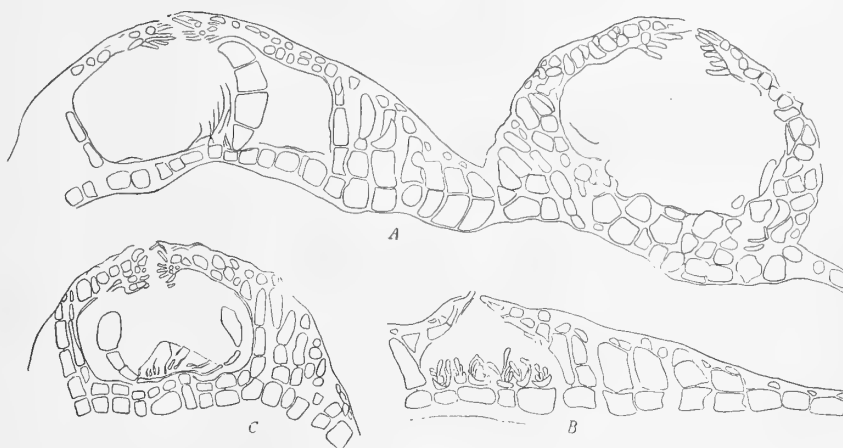


Fig. 171.

Melobesia Fosllei growing on *Corallina officinalis* from ZC¹, north of Læsø. A, vertical section of frond with two conceptacles, one hemispherical, the other depressed. B, vertical section of frond with antheridial conceptacle. C, vertical section of cystocarpic conceptacle. A and C 260:1. B 420:1.

tacles more resemble those of *M. limitata*, but this species is more different principally by the stronger development of the filaments surrounding the ostiole. It much resembles *M. minutula* Fosl. (comp. FOSLIE Remarks p. 107) from which it differs by its more incrustated frond and by the usual presence of trichocytes. Whether it can be kept distinct from it must be decided by further investigations.

Localities. **Sk**: YN², south-east of Bragerne, on *Polysiphonia nigrescens* and *violacea*, July; Lønstrup, on *Corallina rubens*, washed ashore, June (C. H. Ostenfeld). — **Kn**: Within Deget near Frederikshavn, on *Cor. rub.* (C. H. Ostenf.); north-east of Hirsholmene, 6–7,5 meters, August, (C. H. Ostenf.); TL, north of Læsø, on *Cor. rubens*, Sept.; ZL¹, north of Læsø, 9,5 meters, on *Corallina officinalis*, July; TP, Tønneberg Banke, 16 met., on *Cor. rubens*, Sept.

5. *Melobesia minutula* Fosl.

Fosl., Algolog. Notiser, 1904, p. 8; Remarks, 1905, p. 107.

Lithocystis Allmanni Harvey, Phyc. Brit. Vol. II, plate 166, 1849 (?).

Melobesia inæquilatera Solms, Corall., 1881, p. 12, Taf. III fig. 13–18 (?).

Non *Epilithon Van Heurckii* F. Heydrich in J. Chalon, Liste des Algues mar. obs. jusqu'à ce jour entre l'embouchure de l'Escaut et la Corogne, 1905, p. 207, fig. 1–5.

FOSLIE has referred to this species some specimens growing on Bryozoans attached to *Polysiphonia elongata* collected by me in the northern Kattegat (comp. Remarks p. 109). They form small, scarcely incrustated fronds consisting of a single layer of low cells, irregular in outline but not lacunose, wherefore it has been referred to f. *typica*. The frond is monostromatic in its whole extent to the border of the conceptacles. When seen from above, the cells are usually 7–10 μ broad, of the same length or a little longer. Very small hyaline cortical cells are as a rule present, covering the pericline walls. According to FOSLIE, they "mostly seem to be wanting", which statement is probably founded on the fact that they are only

discernible by rather high magnifying powers, owing to their small size and transparency. They are narrower than in the other *Melobesiæ* examined by me. They were also found over the periclinal walls situated under the pseudodichotomies (fig. 172), a fact in accordance with the complete absence of trichocytes.

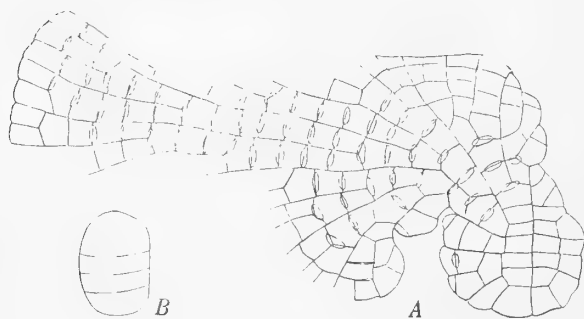


Fig. 172.

Melobesia minutula. A, part of a frond seen from above, at right the primary disc. The cortical cells have not been drawn in the upper and under part of the figure. B, a tetrasporangium. 350:1.

them about 90 μ in diameter (fig. 173). The sporangia were found to be tetrasporic (fig. 172 B), 43–54 μ long, 24–31 μ broad. FOSLIE found them only disporic. —

The sporangial conceptacles are conical-hemispherical with a small orifice surrounded by a whorl of cells radiating towards it. I found

Further statements as to this species cannot be given owing to the very scarce material at hand.

The synonyms given are all dubious, as also mentioned by FOSLIE. The species described by HEYDRICH resembles FOSLIE's species by the structure of the frond, but if his description is correct, it cannot be identical with it, and must even belong to another genus, as the conceptacle is said to have as many openings as it contains sporangia. HEYDRICH's description of the cortical cells also does not agree with those of *M. minutula*, as they are said to cover the half of the cells of the disc; in *M. minutula* they are very narrow, covering only a small part of the underlying cells. It must therefore be concluded that HEYDRICH's species cannot be identified with *M. minutula*.

The plant was found growing not only on the Bryozoan but also on *Ceramium tenuissimum* attached to the same *Polysiphonia*.

Locality. **Ku:** TP, Tønneberg Banke, 16 meters, September.

6. *Melobesia trichostoma* sp. n.

Frons primo monostromatica, dein, saltim maxima ex parte, polystromatica, usque ad 8 cellulis crassa, plerumque tamen e pluribus lobis vel frondibus secundariis minoribus, partim sese invicem obtegentibus composita, lobis plerumque usque ad marginem polystromaticis. Cellulæ frondis monostromaticæ vulgo $7-8\mu$ crassæ, latitudine plerumque paulo longiores, cellulis corticalibus transverse ellipticis munitæ. Frons adulta e filis verticalibus composita, cellulis longitudine vario, latitudine 1—3-plo longioribus. — Conceptacula sporangifera verruciformia, parum elevata, superne applanata, diametro $160-280\mu$. Tectum planum, crassum, c. 5 cellulis crassum. Ostiolum pilis numerosis, sursum longioribus, superioribus ex ostiolo prominentibus ornatum. Sporangia tetraspora, $42-63\mu$ longa, $17-29\mu$ lata. Conceptacula mascula non prominula, ostiolo in tubo longo, sæpe curvato, protracto. Spermatangia lineari-clavata in fundo plano conceptaculi e cellulis depressis procreata, dense stipata. — Conceptacula cystocarpifera eadem forma magnitudineque ac sporangifera et peristomio simili ornata.

The specimens on which this species is founded formed dull rose-coloured crusts on the shells of living *Trochus cinerarius* collected in the Limfjord. They were referred to *Lithothamnion Lenormandi* by FOSLIE in 1905 and are also rather like old specimens of that species, especially the forma *squamulosa*. The frond is at first monostromatic, and the marginal part may remain so, much resembling that of *M. Lejolisii*, with well developed cortical cells, which seen from above are elliptical. A parietal body, situated closely at the outer wall in these cells is very intensely

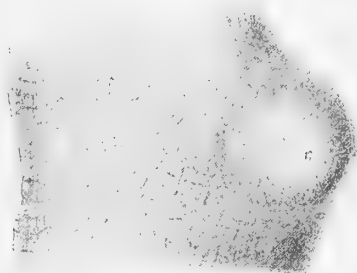


Fig. 173.

Melobesia minutula. Part of frond with conceptacle. 200:1.

stained by hæmatoxyline (fig. 174 A). Trichocytes may occur. The greater part of the crust is polystromatic, being composed of vertical cell-rows, up to 8 cells high or more. The older parts of the crusts are very irregular, being composed of several smaller crusts or lobes growing partly over each other. These partial fronds or

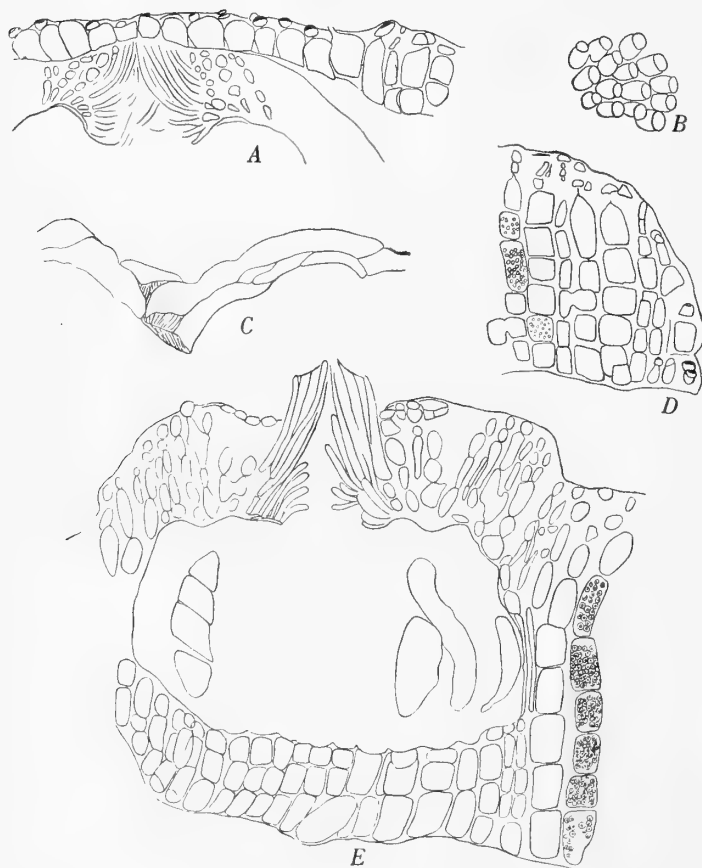


Fig. 174.

Melobesia trichostoma. A, vertical section of the monostromatic part of a frond growing over the conceptacle of another frond of the same species. B, monostromatic frond seen from above. C, vertical section of older, compound crust. D, vertical section of a thick lobe of frond. E, vertical section of sporangial conceptacle. C, 65:1, the rest 350:1.

lobes are usually polystromatic to the very margin. The compound crusts may be composed of lobes of the same frond or of different fronds growing together; it is therefore impossible to state the diameter of the single frond. In the thicker fronds, the upper ordinary frond-cell may bear more than one cortical cell, frequently one over the other (fig. 174 A, D). In the last-named figure the three undermost cells at right bear each a cortical cell, the explanation of which must be that they represent the monostromatic border of the frond, which has been overgrown by tissue produced by the neighbouring thicker part of the same frond. A similar process often takes place in various parts of the frond and gives rise to the complicated structure of the old crusts, new lobes developing from certain

parts of the frond, and growing over the neighbouring parts. — The length of the cells of the vertical cell-rows is highly variable, usually one to three times as long as the breadth, and irregularly varying in the same filament. The undermost cell-layer is not distinct from the others, its cells being of variable height. The cells contain often numerous starch-grains. Transversal pores between the cells of different cell-filaments never occur, but transversal fusions are frequently met with, between the cells of the basal layer and between cells of the upper parts of the vertical cell-rows as well (figs. 174, 175).

The outer part of the sporangial conceptacles (fig. 174 *E*) is low, wart-like, with plane upper face. The outer diameter of the conceptacle is often difficult to state, as it is usually for a great part sunk in the frond, and the outer delimitation often indefinite. One to three layers of cells are present under the conceptacle. The roof is flat, thick, about 5 cells thick. The ostiole is clothed with numerous well-developed unicellular hairs, the uppermost of which are long, and protruding outside the ostiole; the undermost ones are shorter and more oblique or horizontal. They are all intensely stained by hæmatoxyline. The sporangia do not occupy the central portion of the conceptacle, where a small columella of sterile cells is sometimes to be found. The ripe sporangia are always tetrasporic. A small stalk-cell is present under the sporangia (not shown in the figure).

The antheridial conceptacles (fig. 175 *A*) much resemble those of *M. subplana* (comp. fig. 161), being provided with a similar tube, and the antheridia having the same shape and position as in that species.

The cystocarpic conceptacles (fig. 175 *B, C*) have the same shape and size as the sporangial ones, and the ostiole is endowed with a similar peristome. The thick roof is plane, or a little depressed near the ostiole. The carpospores are, as usually, produced seriatly at the periphery of the conceptacle.

The species appears fairly distinct from all hitherto described species of the genus *Melobesia*. The low conceptacles with the thick, flat or a little deepened roof distinguish it from other species of the genus having a well developed peristome (e. gr. *M. Lejolisii*, *coronata*). Its occurrence on mollusc shells, unusual for the genus *Melobesia*, might seem grounds for placing it in the genus *Lithophyllum*; the want of transversal pores between the frond cells and the fact that these cells are not arranged in transversal rows, however, preclude its adoption in that genus.

Locality. **Lf**: Søndre Røn by Lemvig, near the surface of the water, September.

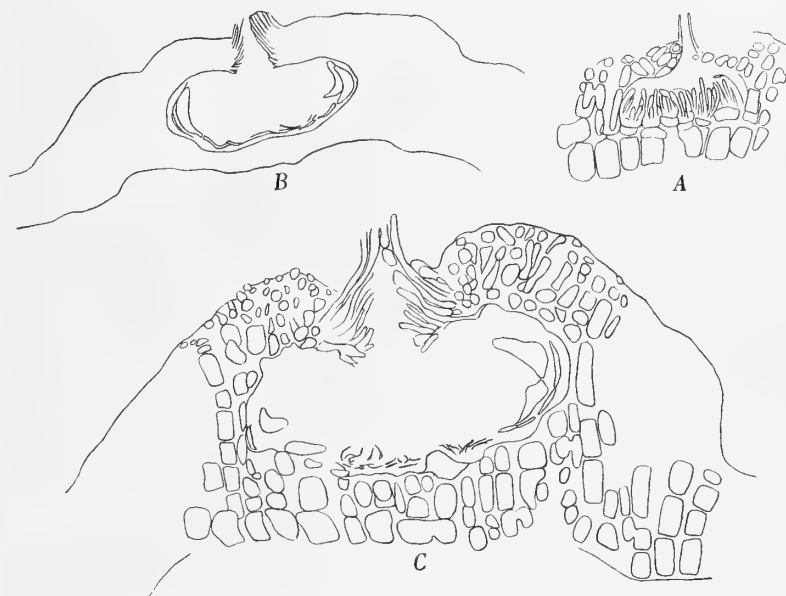


Fig. 175.

Melobesia trichostoma. *A*, vertical section of antheridial conceptacle. *B* and *C*, vertical sections of cystocarpic conceptacles. *A* and *C* 350:1. *B* 65:1.

7. *Melobesia microspora* sp. n.

Frondes suborbiculares, sæpe confluentes, 1–2 mm diametro, excepta parte marginali polystromaticæ, e filis verticalibus usque ad 7-cellularibus compositæ; cellulis filorum 6–8 μ latis, diametro vulgo 1–2-plo longioribus, cellulis strati basalis plerumque brevioribus. Cellulæ corticales desunt. — Conceptacula numerosa contigua vel subcontigua. — Conceptacula sporangifera depresso-hemisphærica vel conica, diametro 120–140 μ , ostiolo vix papilloso, medio nonnunquam columella munita. Sporangia parva, 17–24 μ longa, (9–)11–12(–16) μ lata, semper 4-partita. Sub conceptaculis 1–4 strata cellularum vegetativarum. — Conceptacula mascula parva, paulo prominula vel omnino immersa. Spermatangia elongata vel clavata, fundum planum conceptaculi investientia. Spermatia lineari-clavata, nonnunquam leniter curvata, c. 6 μ longa, 2 μ lata. — Conceptacula feminea ut videtur forma structuraque conc. sporangiferis similia. — Hab. in fronde *Furcellariæ fastigiatae*.

The species here described has only been met with once, viz. on a specimen dredged in the bay of Aarhus. The specimens were determined by FOSLIE as *Melobesia Lejolisii* Rosan. *forma*, but as will be seen from the description given here, it is very different from that species, particularly in the structure of the frond and the small dimensions of the sporangia.

The greater part of the frond is polystromatic; only the marginal part is monostromatic, but it is early divided by horizontal walls, and the frond is then composed of vertical filaments composed of from two to seven or eight cells. These filaments are usually 6–8 μ broad and consist of cells of varying length, usually 1 to 2 times as long as broad. The cells of the basal layer are rather varying in height, but they are usually lower than broad. There is thus no contrast between the basal layer and the perithallium. Seen from above, the cells of the basal layer show a breadth of 5–8 μ , about the same length or a little more, and appear to be frequently connected by lateral fusions (fig. 176 C). Such fusions may also occur between cells above the basal layer, but transversal pores (secondary) nowhere occur. It is remarkable that cortical cells as those characteristic of the other *Melobesia* species do not occur. When seen from above, the superficial cells present themselves as nearly quadratic cells arranged in rows, but no small cells cut off from them appear, not even after staining with hæmatoxyline, by which treatment the walls of all the outer cells and the cuticle are very intensely stained. Hair-cells were not observed.

The conceptacles are numerous, occupying most part of the crust, frequently contiguous, giving the frond a verrucose aspect. The sporangial conceptacles are depressed hemispherical or more rarely low conical. A more or less developed central narrow columella is not infrequently present. The sporangia which do not occupy the centre of the conceptacle are remarkably small; they are always four-parted, the three septa approaching each other in the middle of the sporangium (fig. 177 A). When seen from above, the small ostiole is seen to be surrounded by

small-celled filaments radiating towards the centre. In a vertical section these filaments are only little conspicuous, and there are only feeble rudiments of papillæ in the conical orificium (fig. 177). One to four layers of vegetative cells are to be found under the conceptacles.

The antheridial conceptacles are small, sometimes entirely immersed, usually, however, more or less prominent. The inner cavity has a flat bottom, and may be about 40μ in diameter. The ostiole is not prolonged in a spout.

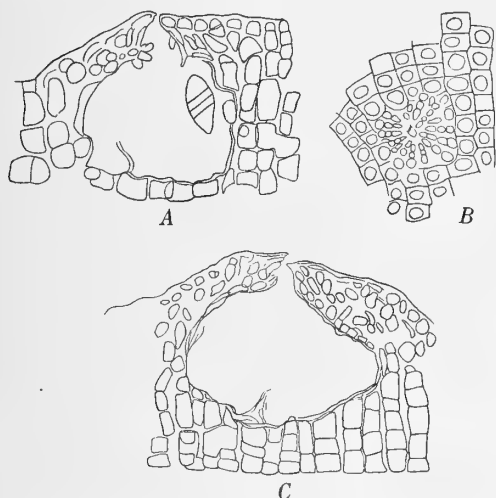


Fig. 177.

Melobesia microspora. A, vertical section of sporangial conceptacle with a tetrasporangium. B, sporangial conceptacle seen from above. C, emptied sporangial conceptacle showing the rest of the columella. 350:1.

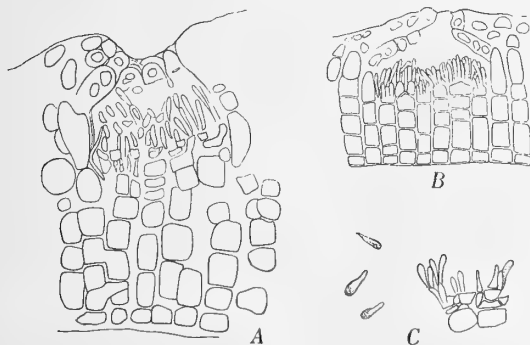


Fig. 178.

Melobesia microspora. A and B, vertical sections of frond with antheridial conceptacles. C, spermatangia and spermatia. A and C 560:1, B 350:1.

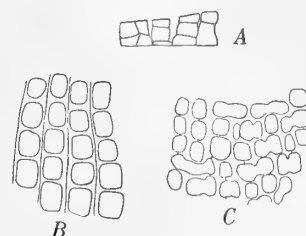


Fig. 176.

Melobesia microspora. A, vertical section of thin crust. B, surface view of crust near the border. C, basal layer seen from the face, showing numerous fusions. 350:1.

The spermatangia form a covering on the bottom of the conceptacle; they are produced from small squarish or trapezoid cells, and are lengthened, upwards incrassated, sometimes a little curved cells. Sometimes the spermatangia are produced not directly from the small squarish cells but from cells of the same shape as themselves (fig. 178 C at left). The spermatia are clavate, broadest in the upper end, sometimes slightly curved, about 6μ long, and 2μ broad at their broadest end, (fig. 178 C). Under the bottom of the conceptacles up to 5 layers of vegetative cells may be found.

Of female conceptacles I have only met with very few, which gave no clear idea of their structure. They seem to be similar in shape and structure to the sporangial ones. Fig. 179 shows a conceptacle containing carpogonia and trichogynes; at left is shown a carpogonium from another section of the same conceptacle.

This species seems to be quite distinct from all well known species of the genus. The want of cortical cells is indeed so remarkable as possibly to suggest

that it should be referred to another genus; but as other characters justifying its removal from the genus *Melobesia* are not known, I prefer to retain it under the

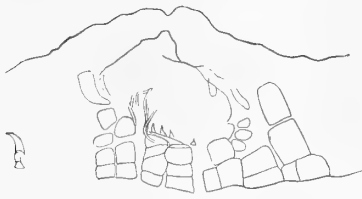


Fig. 179.
Melobesia microspora. Vertical section of female conceptacle; at left a carpogonium from another section of the same conceptacle. 420:1.

genus provisionally. The small size of the tetrasporangia seems to be a significant mark distinguishing it from other species. The want of transversal pores between the cells of the vertical filaments, and the fact that these cells are not disposed in transversal rows, exclude it from the genus *Lithophyllum*.

Only found once, growing on the frond of *Furcellaria fastigiata*, with ripe sporangia, ripe antheridia and carpogonia in April.

Locality: **Sa**: PP, Ryes Flak, 5 meters (no. 4670).

Choreonema Schmitz.

1. *Choreonema Thuretii* (Bornet) Schmitz.

Fr. Schmitz, Uebersicht, Flora 1889, p. 21 (reprint); id. in Engler u. Prantl, Nat. Pflfam. I p. 541; Fr. Minder, Die Fruchtentwicklung von *Choreonema* Thur. Diss. Freiburg, s. a.
Melobesia Thuretii Bornet in Thuret, Etudes phycolog., 1878, p. 96, pl. 50, fig. 1—8; Solms-Laubach, Corallinalgen d. G. v. Neapel, 1881, p. 12, 54, Taf. III fig. 1, 4—10.
Endosiphonia Thuretii Ardissonne, Phycologia mediterranea. I. Varesè, 1883, p. 451.

This interesting Alga, parasitic in *Corallina rubens*, has been met with in a few localities in the Northern Kattegat and perhaps also in the Skagerak. Unfortunately, the collected material was lost, except that from a single locality near Frederikshavn; I must therefore content myself with referring to the quoted publications.

MINDER has in his important paper given a thorough description of the development of the cystocarp, which in essential points modifies the statements of SOLMS-LAUBACH. After fertilization, the zygote gives off short sporogenous filaments, which gradually fuse with the auxiliary cells, but none of the numerous sporogenous nuclei enter into these cells. From the marginal lobes of the resulting great sporophytic cell (which is not produced by mutual fusion of the auxiliary cells, but has been nourished by them) the carpospores are produced, becoming cut off by watch-glass-formed walls.

As I have had very few specimens at my disposal, I cannot give any statement as to the fructification in the Danish waters,

Localities. **Sk** (?). — **Kn**: Within Deget near Frederikshavn (C. H. Ostenfeld), and perhaps a few other localities.

Lithophyllum Phil.

Subgenus *Eulithophyllum*.

1. *Lithophyllum orbiculatum* (Foslie) Foslie.

Foslie, Rev. survey (1900) p. 19 (without mention); Remarks (1906) p. 112.
Lithothamnion orbiculatum Foslie, Norw. Lithoth. (1895), p. 143, pl. 22 fig. 10—11.

The crust is generally orbicular, scarcely exceeding 2 cm in diameter. In one locality only I found larger crusts expanded over stones; as these crusts also in other respects differed from the others, they will be mentioned separately below. The crusts are 1 to 1.5 mm thick.

According to FOSLIE, the hypothallic layer mainly resembles that of *Lithoth. laeve*, being rather feebly developed (Remarks p. 112). I found it, however, always consisting of one layer only, the upright filaments springing out from it in a vertical or nearly vertical direction. The thickness of the perithallic cells varies between 6 and 9 μ ; the height

is generally greater than the breadth, often about double (about 13 μ), but it may be of the same size or even smaller. FOSLIE describes these cells as squarish; I found them generally more or less roundish, frequently approaching the ellipsoid or globe. They are connected with the cells of the neighbouring filaments through transversal pits situated about in the middle of the cells; in transverse sections 3 to 5 such pits are seen in each cell (fig. 180 C). The crust is traversed by horizontal limiting lines which are stained intensely blue by hæmatoxyline; they are often seen crossing the middle of the cells (fig. 180 A). Mme LEMOINE did not find such limiting lines in any species of *Lithophyllum* (Struct. p. 28). The cells of the perithallium are frequently filled with starch grains, particularly in the under part of the crust. The surface of the frond is frequently much inclined towards the border, which in vertical section shows a great marginal cell (fig. 180 D).

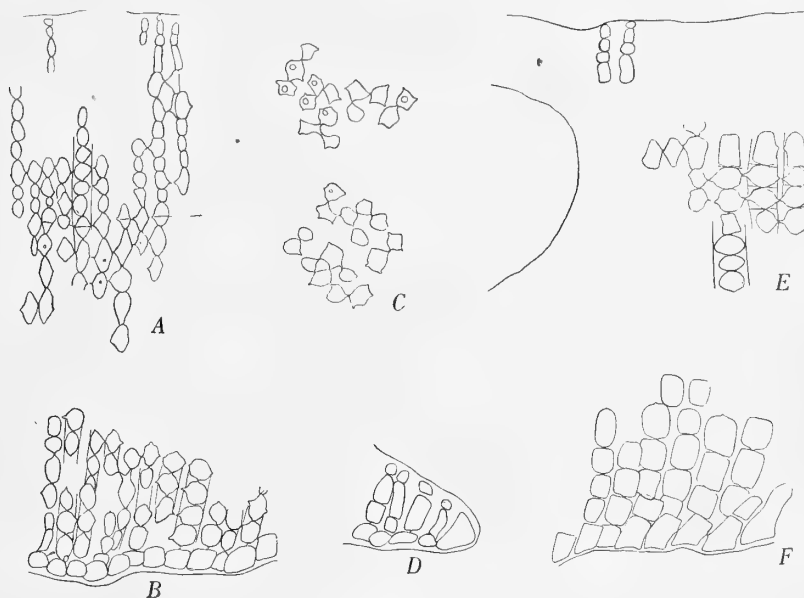


Fig. 180.

Lithophyllum orbiculatum. A, vertical section of crust; B, under part of the same crust. C, horizontal section of crust showing the transverse pits. D, vertical section of margin of frond. E and F, vertical sections of aberrant specimen (no. 5341), F, showing the hypothallium. 350 : 1.

are connected with the cells of the neighbouring filaments through transversal pits situated about in the middle of the cells; in transverse sections 3 to 5 such pits are seen in each cell (fig. 180 C). The crust is traversed by horizontal limiting lines which are stained intensely blue by hæmatoxyline; they are often seen crossing the middle of the cells (fig. 180 A). Mme LEMOINE did not find such limiting lines in any species of *Lithophyllum* (Struct. p. 28). The cells of the perithallium are frequently filled with starch grains, particularly in the under part of the crust. The surface of the frond is frequently much inclined towards the border, which in vertical section shows a great marginal cell (fig. 180 D).

The conceptacles of sporangia are completely immersed; they had in the specimens examined a transverse inner diameter of 92–116 μ ; they are generally almost globular in a vertical section. They have a single pore in the middle of the roof

which is not surrounded by peculiarly shaped cell-rows. The sporangia are four-parted; I found them $70\ \mu$ long, $24\text{--}35\ \mu$ broad, thus somewhat smaller than indicated by FOSLIE. However, I have only met with a small number of well developed sporangia; I am therefore also unable to state whether they are placed over the whole conceptacle or only in its periphery. A group of sterile filaments in the middle of the floor was not observed. The emptied conceptacles are limited by a sharp inner contour.

Supposed antheridial conceptacles are shown in fig. 182. They had a transverse diameter of $60\text{--}77\ \mu$ and the slightly prominent pore surrounded by a number of

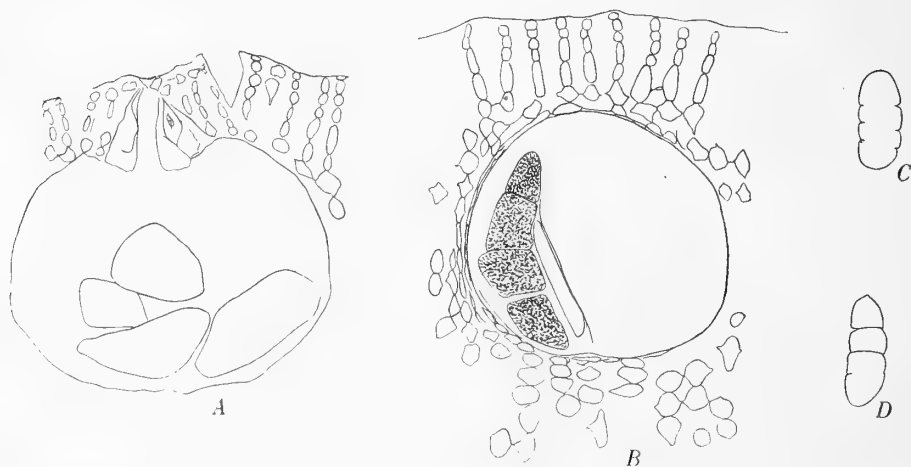


Fig. 181.

Lithophyllum orbiculatum. A, vertical section of tetrasporic conceptacle showing the pore. B, similar, but somewhat excentric section. C and D, feebly developed, not yet fully divided sporangia. 350:1.

peculiarly formed narrow, obliquely upwardly directed filaments, forming the central part of the roof. The rather plain floor was in some cases covered by a very small-celled layer which had probably supported the spermatangia. In some of these conceptacles small bodies were seen which were supposed to be spermatia.

The conceptacles of cystocarps are entirely immersed (fig. 183); they have an inner diameter of $112\text{--}142\ \mu$. (According to FOSLIE it is $200\text{--}300\ \mu$, but it is not stated if it is the inner or the outer diameter). The pore is surrounded above by obliquely upward directed filaments resembling those of the antheridial conceptacles; but below them is situated an inner crown composed of obliquely downward directed cells. Fig. 183 A shows a number of carpogonia in the central part of the floor, those situated nearest the centre having the longest trichogynes. The carpogones are produced from the margin of the disc-cell at the base of the conceptacle (fig. 183 B). The inner crown of the peristome keeps for a long time in the overgrown conceptacles.

According to FOSLIE (Remarks p. 113) "the conceptacles do not become gra-

dually overgrown, as far as hitherto seen". It may happen that the emptied conceptacles are filled with filaments growing out from the bottom of the conceptacle, but it also not unfrequently occurs that they are overgrown without being filled, and empty conceptacles are thus found at various depths in the thicker crusts. This was observed with all kinds of conceptacles.

As mentioned above, I found in one locality (TL, north-west of N. Rønners Rev, 4—5,5 m, Sept. 1894, n° 5341) some specimens somewhat different from the

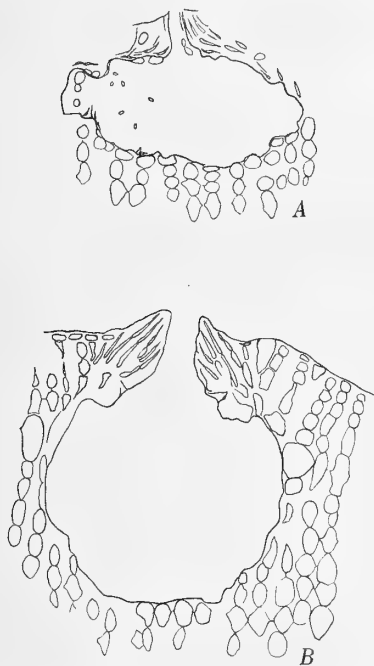


Fig. 182.

Lithophyllum orbiculatum Supposed antheridial conceptacles. In A small bodies are seen which are probably spermatia. 350:1.

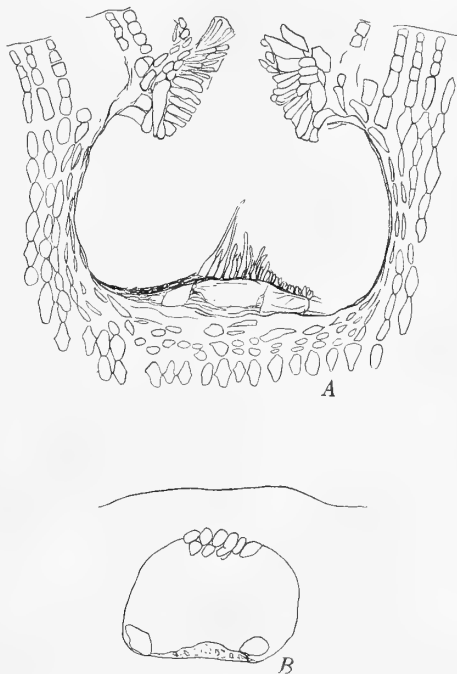


Fig. 183.

Lithophyllum orbiculatum. Cystocarpic conceptacles, A, showing the pore and the carpegonia. 350:1. B, excentric section showing the inner crown and two carpospores at the periphery of the disc. 200:1.

ones just mentioned. They form much more expanded crusts, up to 10 cm or more in diameter, and the cells of the perithallium are thicker, 9—12 μ broad, 7—16(25) μ long. These measurements, however, are only little different from those given by FOSLIE, who has also determined these specimens as *Lith. orbiculatum forma*. The hypothallium consists, as in the other specimens, of a single cell layer, but the cells are frequently elongated obliquely upwards, in the same direction as the perithallic filaments, and they are similar to the cells of these filaments (fig. 180 E, F). The examined crust contained sporangial conceptacles 77—122 μ in diameter, with a single pore; in an old conceptacle a few not exhausted two-parted sporangia were still present. It must be left to further investigations to determine whether these specimens really belong to *L. orbiculatum*.

FOSLIE discusses (Remarks p. 113) the question, whether this species might possibly be a northern form of *Lithophyllum incrustans*. This supposition would not agree with the fact that the last named species, according to Mme LEMOINE (Struct. anat. pl. IV fig. 1), has a much developed hypothallium. On the other hand, a specimen collected by me at Cherbourg and determined by FOSLIE as *Lithophyllum incrustans*, showed a one-layered basal layer and on the whole the same anatomical structure as *L. orbiculatum*. The question as to mutual relation of the two species must therefore be left undecided.

The species has in the Danish waters only been found in the northern, eastern and southern Kattegat and in the Sound. It has been met with in depths from 16,5 to 24,5 meters. The aberrant specimens were dredged in a depth of 4—5,5 m.

Localities. **Ku**: TL, N.W. of Læsø, 4—5,5 meters, large crusts, Sept., n° 5341 (see above). — **Ke**: IR, Groves Flak, 24,5 meters; IK and IH, Lille Middelgrund; IA, Store Middelgrund. — **Ks**: HO, east of Hesselø. — **Su**: bM, south of Hveen, 12,5 meters.

Subgenus *Dermatolithon* Foslíe.

As mentioned above, p. 236, the genus *Dermatolithon* was established by FOSLIE in 1898 (List of Spec., p. 11), only however as a *nomen nudum*, and the following species of *Melobesia* were referred to it: *M. pustulata*, *Lejolisii* and *hapalidioides*. In 1900 (Rev. syst. Surv., p. 21) the genus was described and *M. macrocarpa* was further referred to it, besides two uncertain species, while *M. Lejolisii* was removed from it. It was founded on characters of the sporangial conceptacles (comp. p 237). Later on (Algol. Not. I, 1904, p. 3), FOSLIE judged that these characters were of small systematic value, he pointed out the relations of these species to the genus *Lithophyllum*, and transferred *Dermatolithon* as a subgenus under *Lithophyllum*, characterized by having the hypothallium formed by a single layer of inclined cells, in contradiction to *Eulithophyllum* and *Lepidomorphum*, the hypothallium of which always consists of several cell-layers. Three years later (Algol. Not. VI, 1909, p. 58) FOSLIE raised it again to a distinct genus characterized only by the last-named character. As mentioned above, the species of *Dermatolithon* agree with *Lithophyllum* in the presence of transversal pits between the vertical cell-rows. A difference is certainly said to exist in the hypothallium being in *Dermatolithon* monostromatical, while it is polystromatical in *Lithophyllum*; but FOSLIE admits himself that the hypothallium may sometimes be partly polystromatical in *Dermatolithon*, (1909, p. 57). And in *Lithophyllum orbiculatum* mentioned above there is evidently a monostromatical hypothallium (fig. 180). Further, in *Dermatolithon*, the cells of the hypothallium are usually long and oblique, but they may also be rather short and only little inclined (fig. 189), which may likewise be met with in *Lithophyllum*, e. g. in *L. orbiculatum*, fig. 180 F. It must therefore be concluded that *Dermatolithon* cannot be kept distinct from *Lithophyllum* as a separate genus, at all events on the basis of the anatomical structure, but must be regarded only as a subgenus.

Lithophyllum Corallinae (Crouan), which was already in 1897 transferred from the genus *Melobesia* to *Lithophyllum*, seems particularly to be a connecting link between *Dermatolithon* and the typical *Lithophyllum*.

2. *Lithophyllum macrocarpum* (Rosan.) Foslíe.

Foslíe, Remarks, 1905 (1906), p. 128; M. B. Nichols, Contribut. to the knowledge of the Californ. spec. of crustaceous Corallines. II. University of California Publ. in Botany. Vol. 3, No. 6, 1909, p. 352, figs. 12, 15, 16, 17; Foslíe, Algol. Notiser VI, 1909, p. 47.

Melobesia macrocarpa Rosanoff, Recherches, 1866, p. 74, pl. IV, figs. 4—8, 11—20.

Dermatolithon macrocarpum Foslíe, Rev. Surv., 1900, p. 21; Algol. Not. VI, 1909, p. 58.

f. *typica* Foslíe.

L. pustulatum (Lamour.) Foslíe f. *macrocarpa* (Rosan.) Foslíe, Remarks, p. 117.

It seems that only the specimens from one locality growing on *Phyllophora membranifolia* are with certainty referable to the typical form which, according to FOSLÍE, differs from the following form by the frond attaining a greater thickness and by the sporangial conceptacles being up to 600μ in diameter but a little lower proportionally to the diameter. The frond of the named specimens, however, attains only a thickness of 200μ ; the sporangial conceptacles measured over 500μ , and under them were 3—4 layers of cells. The other specimens referred by FOSLÍE to this variety are partly sterile and only determined with doubt, or they seem not to possess the characters named.

Localities. **Kn**: Trindelen, 15 meters, on *Phyllophora membranifolia*, July, with ripe sporangia. — Further recorded with doubt from the following localities. **Lf**: Nykøbing, on *Chorda Filum*, (Th. Mortensen). — **Kn**: Hirsholmene, on *Fucus vesiculosus*; Nordre Rønner, on *Fucus vesiculosus*; TG, north of Læsø, 9,5 m, on *Phyllophora membranifolia*, sterile.

f. *intermedia* Foslíe.

Foslíe, Remarks, 1905, p. 117; Nichols, Crustaceous Corallines, II, 1909, p. 352, plate 11 fig. 12, pl. 12 figs. 15—17.

L. pustulatum (Lamour.) Foslíe f. *intermedia* Foslíe, Remarks, p. 128.

Most of the specimens of this species have been referred by FOSLÍE to the f. *intermedia*, which has later been carefully described by NICHOLS, l. c. I have nothing to object against the determinations of FOSLÍE, and I shall not enter into the question as to whether the species can be kept distinct from *L. pustulatum*, but will merely remark that I have always found two-parted sporangia. In referring to the quoted descriptions and figures however, some remarks on the Danish species may be added.

These are almost all growing on *Fucus vesiculosus*, where they form crusts measuring 4—7,5 mm in diameter, frequently confluent. The border of the frond, which is not always adherent to the substratum, consists of a single layer of long oblique cells, each bearing a cortical cell cut off by an oblique wall. Later on, the long cells are divided by a transversal wall, the crust thus being composed of two

layers of cells, not including the cortical cells, and further transversal divisions frequently do not occur except in the immediate vicinity of the conceptacles; it may even happen that the frond is monostromatic in almost its whole extent. The long cells in the upper layers are always connected with transversal pits (fig. 184). The thickness of the frond is rather variable. Monostromatic fronds were 25–42 μ thick, fronds consisting of two layers of cells 67–105 μ and fronds containing three layers were 91–123 μ thick. The fronds are frequently growing over each other. It also frequently happens that new growing edges are produced from certain parts of the frond, growing over the neighbouring parts the growth of which has ceased. The long cells contain a small nucleus in the upper part of the cell, and a number

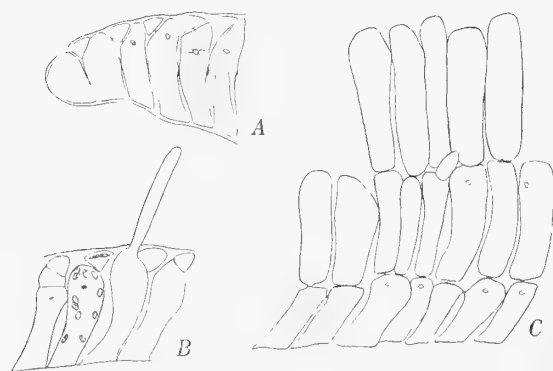


Fig. 184.

Lithophyllum macrocarpum f. *intermedia*. Vertical sections of fronds. A, margin of frond. B, part of monostromatic frond showing a hair-cell and two cortical cells cut off from one cell. C, part of thicker crust; transversal pits between the cells of the two upper layers. 350:1

of small chromatophores spread in the cell. The cortical cells are produced early, immediately after the formation of the long cells by the division of the marginal cell. But at some distance from the margin a new cortical cell may be cut off under the primary one by a horizontal or inclined wall (fig. 184 B), and this process may be repeated several times. Hyaline hairs may be produced from long cells seemingly not different from the others, and provided, like these, with a cortical cell (fig. 184 B). The length of the long cells of the frond varies greatly; when the crust is polystromatic, the cells of the under-

most layer are often rather short. When these cells or those of the monostromatic frond are long, their undermost part is usually more inclined than their upper part (fig. 184 B, comp. NICHOLS, l. c. fig. 12, 15).

The sporangial conceptacles are very prominent, conical with rounded or applanated top, 300–500 μ in diameter. Under the conceptacle 1–3 layers of sterile cells are present. Papillæ projecting inward and upward, lining the pore, as described and figured by NICHOLS, may be found in the under part of the pore, but they are usually slightly developed. Seen from above, the superficial cells surrounding the pore appear scarcely different from the others, the nearest being only a little smaller (fig. 185 B). The sporangia are only placed in the peripheral part of the conceptacle, the central part being occupied by sterile cells forming a conical columella. NICHOLS found also sporangia in the central part, though less numerous there than at the periphery. As shown by this author, each sporangium is born by a stalk cell. A "plug" was found in some rare cases in the ostiole, forming a continuation of the central sterile cells (fig. 185 A), but it seems to be usually wanting,

and was not found by NICHOLS. The sporangia are disporic; they were found to be $105-140\mu$ long, $35-60\mu$ broad; the smallest ones, however, were perhaps not ripe.

Antheridial conceptacles were not observed.

Cystocarpic conceptacles were only found in specimens from one locality (Kalø). They are of the same shape and size (about 400μ in diameter) as the sporangial ones, and the ostiole is of the same structure, being without or only with poorly developed papillæ in the under part. The carpospores are only produced at the periphery.

This variety has only been found growing on *Fucus vesiculosus* and *Fucus serratus* a little below low-water mark. It is particularly abundant in the Limfjord, probably owing to the high salinity and the high summer temperature of this

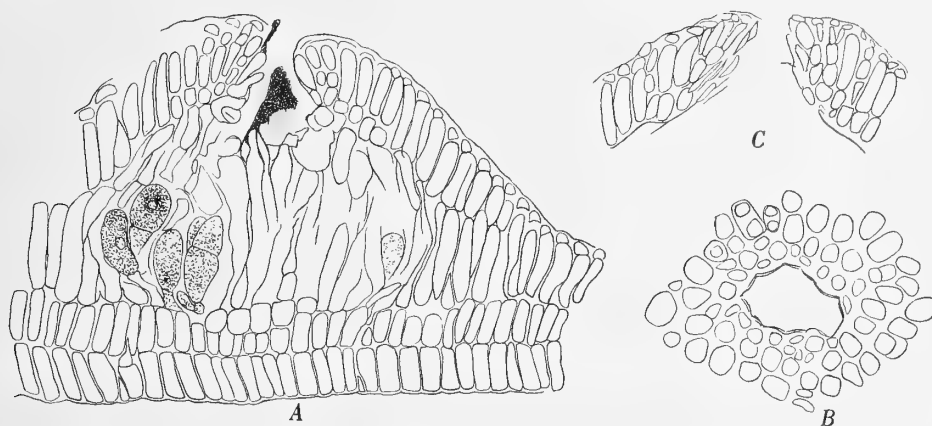


Fig. 185.

Lithophyllum macrocarpum f. *intermedia*. A, vertical section of not quite ripe sporangial conceptacle. B, orifice of sporangial conceptacle seen from above. C, vertical section of orifice of cystocarpic conceptacle. A and C 200:1. B 350:1.

water. Ripe sporangia have been met with in summer, June to September. In April two-parted sporangia were found, but not fully ripe, and in the same month cystocarpia were found.

Localities. **Lf:** Søndre Røn by Lemvig; Oddesund; MH, bank of Skrandrup, MG, off Hanklit, and Thisted in Thisted Bredning; I, Venø Bugt; Nykøbing; Sallingsund, pier; Amtoft Rev; LQ, Lendrup Røn; Løgstør. — **Kn:** Hirsholm and Køpen near Frederikshavn. — **Ks:** Isefjord: on the beach near Frederiksværk (Th. Mortensen); Lammefjord; Holbæk Fjord. — **Sa:** Reef near Kalø; Æbelø. — **Sf:** near Birkholm.

3. *Lithophyllum Corallinæ* (Crouan) Heydr.

F. Heydrich, Corallineae, insbes. Melobesieae. Ber. deut. bot. Ges. Bd. 15, 1897, p. 47.

Melobesia Corallinæ Crouan, Florule du Finist., 1867, p. 150, pl. 20, genre 133 bis, fig. 6—11.

Lithophyllum pustulatum (Lamour.) Fosl., f. *Corallinæ* (Crn.) Fosl., Remarks, 1905, p. 118.

In two localities in the Skagerak a few specimens of a calcareous alga were found growing on *Corallina officinalis* and agreeing with the short description and

the figures of *Melobesia Corallinae* CROUAN (l. c.). These specimens have not been examined by FOSLIE, but as this author regarded CROUAN's species as being only a form of *Lithophyllum pustulatum*, he would probably have referred our plant "as a denominated form" to *L. macrocarpum*, whereas it has disporic sporangia. A closer examination of my specimens, some of which were preserved in alcohol, showed me, however, such differences from the named species that they cannot, in my opinion, be referred to it, but must be regarded as representing a different species bearing CROUAN's name.

The crust is in some cases surrounding the *Corallina*-frond, being attached to it in its whole extent and fusing together where the borders meet. In other cases it is only attached by its central thicker portion, while the thinner edges of the orbicular, peltate frond are free (fig. 187, comp.

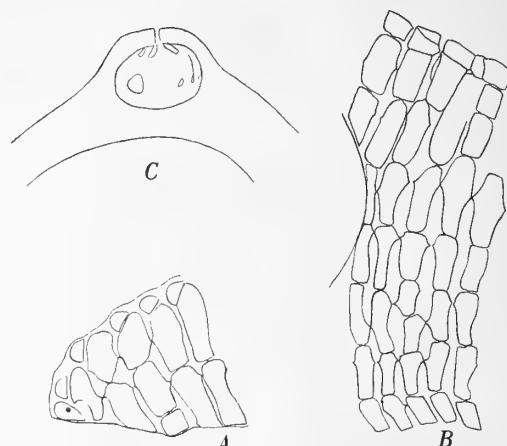


Fig. 186.

Lithophyllum Corallinae, from Hirshals. A, vertical section of edge of frond. 560:1. B, vertical section of frond near a conceptacle. 350:1. C, section of frond with sporangial conceptacle. 65:1.

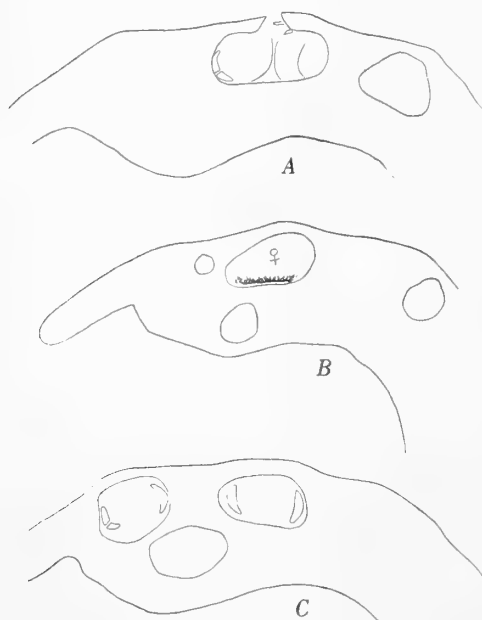


Fig. 187.

Lithophyllum Corallinae, from Hanstholm, vertical sections of scutate fronds with free edges. Sporangial conceptacles in A and C, cystocarpic conceptacles in B. Overgrown conceptacles in B and C. 65:1.

CROUAN, l. c. fig. 6, 7). In the first case the frond was up to 105μ (over 12 cells) thick, in the latter the central part was about 250μ thick, the inner edge $70-105\mu$ thick. The diameter of the peltate fronds is 2–2.5 mm. The edge of the frond is thick, polystromatic to the very margin or nearly so, the cells cut off from the marginal cell dividing early by transversal walls. The marginal cell is much smaller than in *L. macrocarpum* (fig. 186 A). The undermost cell in the vertical or ascending cell-rows constituting the frond is not longer than the others, frequently even shorter, being only 1–3 times as long as broad; these cells are usually inclined. The cells of the upper cell-layers are frequently much longer; the transversal pits of these cells are always distinct; they are shown in fig. 186.

The sporangial conceptacles are only little prominent, forming low warts with

a more or less plane upper face, the cavity being entirely or for the most part sunk in the frond. Their outer diameter is therefore often difficult to state, but it reaches at least $350\ \mu$. The cavity is nearly globular or usually more or less flattened. The ostiole is without or provided with poorly developed papillæ in its under part. In some cases the ostiole was found to be excentric. The sporangia are only placed at the periphery of the conceptacle, the central part being occupied by a conical columella. The sporangia are always disporic, $50\text{--}88\ \mu$ long, $18\text{--}32\ \mu$ broad. The number of sterile cell-layers under the conceptacle varies greatly according to the thickness

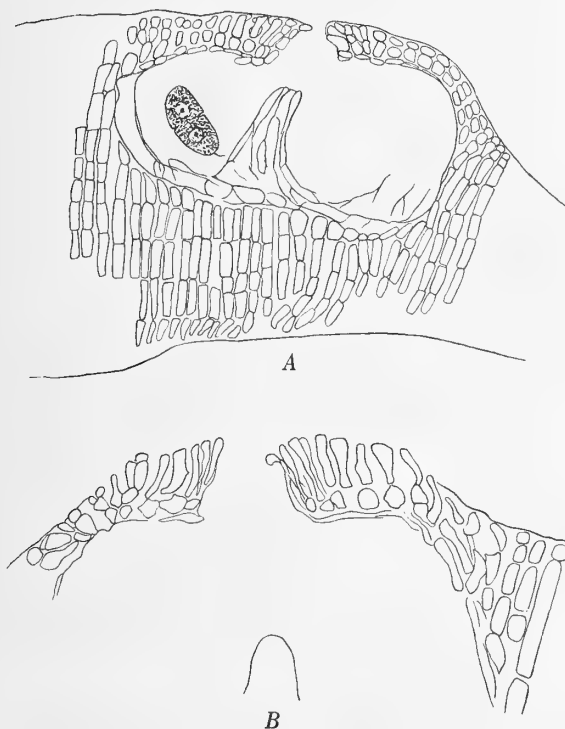


Fig. 188.

Lithophyllum Corallinæ. A, vertical section of sporangial conceptacle. 205:1. B, vertical section of upper part of a similar one. 350:1.

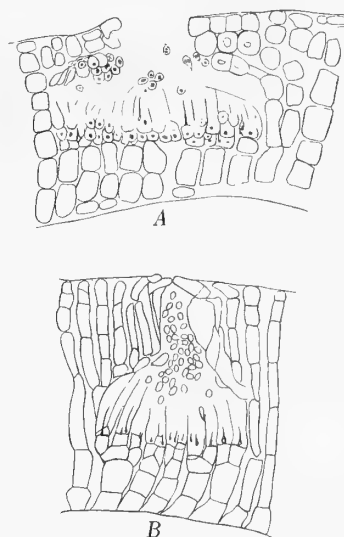


Fig. 189.

Lithophyllum Corallinæ. A, vertical sections of antheridial conceptacles. In A some spermatia show two nuclei. A 350:1. B 370:1.

and age of the frond. In thicker, older fronds the first produced conceptacula after evacuation become overgrown by the continued growth of the surrounding tissue and are later found as empty cavities in the under part of the crust, while new conceptacula are formed at a higher level (fig. 187).

The antheridial conceptacles are entirely sunk in the frond, not prominent, rather low, with a flat bottom and a shorter or longer orifice. The spermatia are produced at the end of long sterigmata given off from small cells covering the bottom of the conceptacle. The ripe spermatia are globular-ovoid, at one end (the basal one) drawn out in a short point. Two nuclei were distinctly visible in isolated spermatia (fig. 189 A).

The cystocarpic conceptacles have the same shape and size as the sporangial ones. The papillæ lining the ostiole were found more developed than in the sporangial conceptacles. The structure of the cystocarp rather resembles that of *Corallina*,

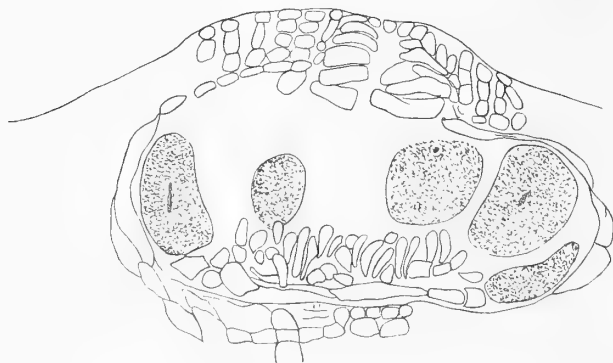


Fig. 190.

Lithophyllum Corallinae. Vertical section of cystocarpic conceptacle. 350:1.

a large disc-shaped cell occupying the bottom of the conceptacle giving off at the periphery seriate carpospores and covered with numerous closely placed oblong cells filled with protoplasmatic contents, the morphological character of which could not be determined, as trichogynes were in no cases observed (fig. 190). The cystocarpic conceptacles become overgrown and sunk in the crust as also the sporangial conceptacles.

The structure of the frond, being polystromatic to the margin, and the slightly prominent conceptacles being sometimes overgrown and deeply sunk in the frond, are the principal characters distinguishing this species from the foregoing, with which it agrees in its disporic, though smaller sporangia. It is apparently not identical with *Melobesia Corallinae* SOLMS (Corall. p. 9, Taf. II, fig. 25, III fig. 21—24) which differs, to judge from the figures, by tetrasporic sporangia, occupying the central part of the conceptacle, by the want of columella, and apparently by the structure of the frond, the basal cell-layer being very low.

Found with sporangia and cystocarps in July and August.

Localities. Sk: YT, YU, Hanstholm, 2—6 meters; Hirshals, on the mole.

4. *Lithophyllum pustulatum* (Lamour.) Foslie forma?

Mention may be made here of an alga recorded once growing on *Corallina officinalis* but which could not be identified with certainty on account of the incomplete state of the present material. It forms thin red crusts, the peripheral part of which is monostromatic with cortical cells, only 14—20 μ thick, while the central portion, consisting of 2—3 cell-layers, besides the cortical cells, has a thickness of up to 80 μ .

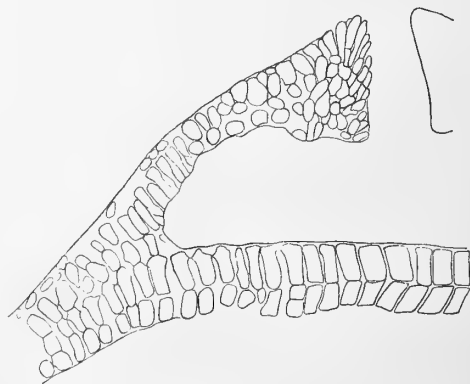


Fig. 191.

Lithophyllum pustulatum forma?. Vertical section of one half of an empty conceptacle. 205:1.

The cells of the vertical cell-rows are proportionally short, and connected with transversal pits. Only empty conceptacles were found. They are about $420\text{--}500\ \mu$ in diameter, conical-subhemispherical, somewhat lower in proportion to the breadth than in *L. macrocarpum*. The roof is of solid structure and is very thick near the ostiole. The cells surrounding the upper part of the ostiole are elongated but not projecting as free papillæ. Our alga reminds one of *L. pustulatum* f. *australis* Foslie (Remarks, p. 117, NICHOLS, Contrib. II, 1909, p. 356, fig. 21—24) from which it differs, however, to judge from NICHOLS' description, by the want of papillæ surrounding the ostiole. As the conceptacles were empty, their nature could not be determined.

Locality: **Ke:** Store Middelgrund 19 meters, May.

Corallina L.

1. *Corallina officinalis* L.

Linné, Fauna Suecica 1761, p. 539; Kützing, Phyc. gener., 1843 p. 388, Taf. 79, Fig. 1; Harvey, Phyc. Brit. II, 1849, pl. 222; J. E. Areschoug in J. Agardh, Spec. II, 2, 1851—52, p. 562; Kützing, Tab. phyc. Vol. 8, 1858, Tab. 66—68; Kny und Magnus, Ueber ächte und falsche Dichotomie im Pflanzenreich. Botan. Zeit. 1872 Sp. 708; Thuret, Études phycologiques, 1878, p. 93 pl. 49; Solms, Corallinalalg., 1881 (*Corallina mediterranea*); Hauck, Meeresalg., p. 281; Guignard, Dév. et const. des anthérozoïdes. Revue gén. T. I, 1889, extrait, p. 50, pl. VI fig. 24—26 (spermatia); B. M. Davis, Kerntheilung in der Tetrasporen-mutterzelle bei *Corallina offic.* Ber. deut. bot. Ges. 1898, Bd. 16 Heft 8, p. 266; K. Yendo, Corallinæ veræ japonicæ. Journ. Coll. of Science. Imp. Univ. Tokyo. Vol. XVI. Art. 3, 1902, p. 28, pl. III fig. 11—13, pl. VII, fig. 10—13; id., Study of the genicula of Corallinæ. Ibid., Vol. XIX, Art. 14. 1904; id., A revised list of Corallinæ. Ibid., Vol. XX, 1905, p. 29; Oltmanns, Morph. u. Biol. d. Algen, I, 1904, p. 562.

The articulated fronds are given off from a basal crust much resembling some crustaceous *Lithothamnia* (comp. HARVEY, l. c.). In some cases it is rather small and gives off numerous closely placed fronds from almost its whole surface. In other cases it is widely extended, up to 2.4 cm. in diameter or more, and bears only a small number of erect fronds (fig. 192). The border is lobed, the lobes being now broad, now narrow. In the latter case the lobes are more or less branched and often keep their independence, being separated by deep furrows when meeting, but it also happens that they grow partly over each other; in other cases, however, they are confluent. Concentric zones are sometimes very distinct. In the anatomical structure they resemble the crustaceous *Lithothamnia*, showing a hypothallium consisting of long cells running in a horizontal direction and a perithallium composed of ascending filaments of shorter cells. The last cell of the latter is very short, the penultimate proportionally long. There seems to be a continuous layer of non-

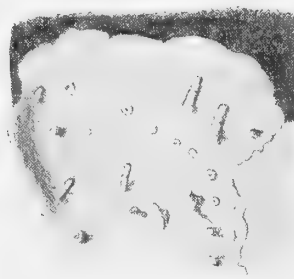


Fig. 192.
Corallina officinalis. Basal crust with scattered articulated fronds or scars after them; at right it meets with a crust of a *Lithothamnion*. 4:1.

dividing cover cells similar to that pointed out for the articulated fronds and for *Lithothamnion* by SOLMS (Corall., p. 27 and 29). The cells of the hypothallium and those of the inner perithallium were, in a specimen collected in July, filled with starch grains, while the cells of the outer perithallium showed numerous disc-shaped chromatophores and a single nucleus.

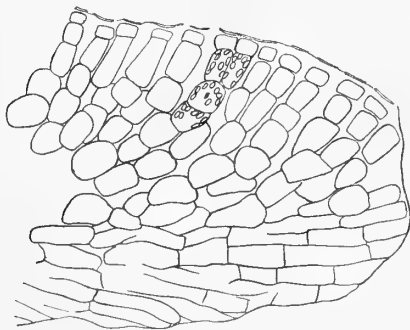


Fig. 193.
Corallina officinalis. Border of basal crust
in vertical section. 390:1.

The articulated fronds are connected with the crust by a geniculum. The ramification is monopodial, in the typical form pinnate. The branches usually arise near the growing point. At an early stage three (or more) small protuberances are seen at the upper end of the last joint, the middlemost of which develops in continuation of the axis. This has been interpreted as trichotomy, or polychotomy (KNY 1872, Sp. 704, SOLMS 1881, p. 30); I think, however, with MAGNUS 1872, p. 721, that there is no reason for this interpretation, and that the middlemost outgrowth must be regarded as the principal axis, the others as lateral branches. In *f. typica* each joint bears two opposite branches, all in the same plane, having for the most part a limited growth, being "pinnulæ", but there is no distinct difference between the pinnulæ and the longer branches with continual growth. It frequently happens, however, that some joints produce more than two branches; 6 branches are not rarely met with and I have found up to 10 lateral branches placed in the same plane on the upper border of a much flattened joint (fig. 194 A). More rarely the supernumerary branches are given off in different directions at the same level, being thus verticillate (fig. 194 B, Plate IV fig. 5); in a specimen from Frederikshavn, a whorl of 8 pinnulæ was found on a joint. It may happen also otherwise, that normal branches are exceptionally given off in a direction diverging from the ordinary plane of ramification. The joints bearing a great number of branches occur principally in the upper part of the shoots produced in a period of growth. Besides the normal branches, adventitious ones occur, though rather rarely (Comp. SOLMS 1, c. p. 29). Their position is less regular than that of the normal branches, and they are usually given off from the under part of the joints.

While in the *f. typica* every joint bears usually two opposite branches, other specimens, especially those growing in deeper water, are less branched, a greater or lesser number of joints bearing no branches, or only one. In these specimens the joints are cylindrical or nearly so, while the joints of the much branched forms are usually more

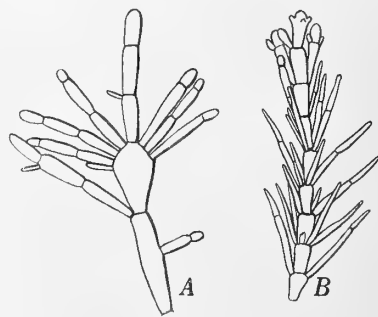


Fig. 194.
Corallina officinalis. A, seriate branches
placed on the border of a joint. B, upper part
of frond with verticillate branchlets. 3:1.

complanated, especially in the upper end of the shoots (Plate IV fig. 6). In specimens from deeper water it sometimes happens that some of the branches assume a special character, growing out as slender, unbranched, irregularly curved organs taking not the upward direction but growing in a transversal direction or more downwards. They resemble either rhizomes or tendrils but have usually not the function of either of these organs (Plate IV fig. 7). It may however happen that the end of such a branch fixes itself on any solid substratum, f. inst. molluscs, *Furcellaria*, *Zostera*, developing an adhesive disc similar to the primary crustaceous frond. It is connected with the ultimate joint by a genicle. Such adhesive discs may also develop at the end of ordinary fronds coming accidentally in contact with any solid body (fig. 195). These discs have the power of producing new articulated fronds, in a similar manner to the primary ones (fig. 195 B).

The age of the articulated fronds is not known. They reach a length of up to 16 cm, usually however only 10 cm. Supposing that a long pinnated shoot is produced every year, it seems probable that the age of the erect fronds does not exceed 3 or 4 years.

The joints consist of a central tissue of elongated cells and a cortex not sharply limited from it, the cell-rows at the periphery of the central tissue bending outwards and consisting of cells becoming gradually shorter outwards. The cells of the central tissue are usually 5—8 times as long as broad; they are disposed in transversal zones, their end-walls being situated about at the same level, the limiting lines being, however, convex upwards (comp. Mrs. WEBER, Siboga pl. XVI fig. 15, 1904). The cells are as usual connected with primary pits at the end walls, while secondary pits do not occur¹⁾, but lateral fusions between the cells of the central strand are very numerous and more than two cells frequently fuse together. As mentioned above, p. 211, I found these fusions followed by a fusion of the nuclei in a tetraspore-bearing plant.

In a female specimen with ripe cystocarps collected in winter at Frederikshavn similar cell-fusions were found, but the behaviour of the nuclei was different, those of the central tissue having divided in two to four, while such divisions were not observed in the tetraspore-bearing plants. It was therefore not easy to decide whether fusion of the nuclei took place in the female plant. It should be of much interest to decide whether there is such a constant difference between the tetraspore-bearing and the sexual plants.

The cortex of the joints is covered with a continuous layer of low cover-cells (comp. Solms, Corall. p. 29).

¹⁾ PILGER states, however, that the longitudinal walls in the central tissue of *Corallina* are provided with pits (1908. p. 252).

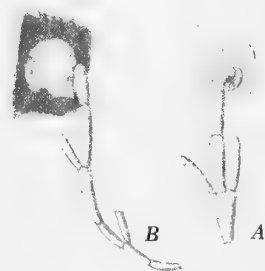


Fig. 195.

Corallina officinalis. A, adhesive disc developed at the end of an ordinary shoot on coming in contact with a shell. B, adhesive disc developed from the ultimate joint of a shoot coming in contact with a rhizome of *Zostera*; scars after articulated fronds developed from the disc but fallen off are visible. 3:1.

The nodes (genicula) consist of a single layer of very long cylindrical cells with attenuated ends continuing into the joints connected by the node. The statement of SOLMS (l. c. p. 28) that these cells are later on divided by a number of thin transversal walls has not been confirmed by YENDO (Genicula, 1904, p. 30), neither have I found these walls. The longitudinal walls of the genicular cells are not incrustated with calcium carbonate, while the attenuated ends (their extragenicular portions, YENDO) are incrustated as the cells of the joints between which they are inserted. For further information on the chemical qualities of the walls of the genicular cells comp. YENDO (l. c.). The node is more or less covered by a cortex which is interrupted in the middle (comp. KÜTZING, Phyc. gen. pl. 79, I).



Fig. 196.

Corallina officinalis. Part of frond with fused male conceptacles. 18:1.

Hyaline hairs were not observed in the Danish specimens of this species, but as they have been figured by THURET in *C. mediterranea* (Ét. phyc. pl. 49 fig. 2 and 4) they will probably also be found in the typical *C. officinalis*.

The three kinds of conceptacula occur, as far as known, always on different individuals (comp. THURET, l. c. p. 93). They are either terminal in the ends of shorter and longer branches, or lateral, sessile on the joints, and the three kinds of conceptacula may all be apical or lateral as well (comp. SOLMS, l. c. p. 5). The lateral conceptacula are frequently placed on the edges of the joints, but their position may also be more irregular on various sides of the branches. In a male specimen which was very densely beset with conceptacles, many of them were fused together. Two or three of them were frequently placed at the same level, forming an incomplete ring at the upper end of the joint, with the ostioles more or less drawn out in a horizontal slit (fig. 196).

As to the structure and development of the conceptacles, reference may be made to the repeatedly quoted papers of THURET and SOLMS on *Corallina mediterranea*, which must be supposed to agree with the typical *C. officinalis* in this respect.

As shown by THURET (l. c. p. 93, pl. 49 fig. 6), the antheridial conceptacles differ from the others in having a conical prolongation containing the ostiole. I found the same in the Danish specimens. The development and structure of the spermatia have been studied by THURET (l. c. p. 95, pl. 49 fig. 7-9), SOLMS (l. c. p. 36, Taf. II fig. 21-23) and GUIGNARD (l. c.).

The development of the cystocarp has been thoroughly described by SOLMS and I must content myself with referring to his paper, remarking however, that the subject needs further examination after the important paper by MINDER on *Choreo-*

nema Thuretii. I have only examined a few fully developed cystocarps on slides made by microtome, and they showed that the formation of carpospores is not always limited to the periphery of the conceptacle, but may also take place from the inner part of the great disc-shaped cell at the bottom of the conceptacle, perhaps only because the border of this cell is lobed.

Referring for the structure and development of the conceptacles of sporangia to THURET (l. c. p. 94, pl. 49 fig. 4—5) and SOLMS (l. c. p. 31, Taf. I, fig. 6—7), I shall as to the sporangia only mention that, after the division of the primary sporangial nucleus into four, a fairly long time elapses before the cell-division begins. A great number of sporangia with four nuclei situated about (not exactly) in a vertical series are therefore to be found (fig. 197 B). This was already observed by THURET, who remarks (l. c. p. 95): “La formation des cloisons est précédée de l'apparition d'espaces clairs qui occupent le centre des futurs spores (fig. 5)”.

As elsewhere (comp. THURET, l. c. p. 95, SOLMS, l. c. p. 5), the sporangia-bearing specimens seem to be more frequent than the sexual ones also in the Danish waters, but I have not sufficient observations to affirm this with certainty.

The species is, as elsewhere, rather variable, but cannot be divided into well defined varieties. When growing at low-water mark or in shallow water it is markedly pinnate, almost every joint bearing a pair of branches, and must be referred to *f. vulgaris* Kützing (Tab. phyc. VIII, p. 32, Tab. 66 fig. 2; *C. officinalis* *a*, Areschoug l. c. p. 562; *C. offic. f. typica* Kjellman, Alg. Arct. Sea p. 86 (114); *C. offic. γ*, Yendo 1902, p. 29, pl. VII, fig. 12, comp. Plate IV figs. 5—6). The specimens growing in deeper water are sometimes not much different from the ones just named, but are usually less branched and have longer joints. In *f. vulgaris*, the length of these does not reach 2 mm, while in the specimens from deeper water it not rarely reaches 3,5 mm, and even a length of 4,5 mm has been met with. In the extreme forms, the ramification is scarce and irregular, not pinnate, and the branches are often given off at various sides, though a tendency to branching in one plane is to a certain degree pronounced. Such forms may be named *f. profunda* Farlow (Mar. Alg. New. Engl., 1881, p. 179). In the Kattegat and the Samsø waters they are frequently coarser than the typical form, the joints being cylindrical, about 1 mm thick, and agree then fully with the description of *f. robusta* Kjellm. (l. c. p. 86 (114)). This form has been collected in several places in the named waters in depths from 10 to 19 meters (Plate IV fig. 8).

The species is commonly spread in all the Danish waters with proportionally high salinity, including the Samsø waters, where it is very common. It grows usually on stones, but may also be fixed to shells of molluscs (*Purpura*, *Littorina*, *Buccinum*, bivalves), on wood, and more rarely on Algæ (*Furcellaria*). It often forms associations

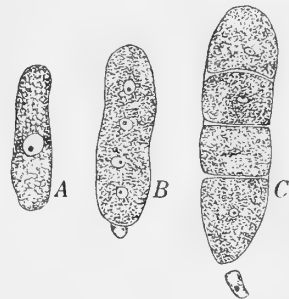


Fig. 197.
Corallina officinalis. A, with undivided nucleus; B, with four nuclei but yet undivided; C, with completed divisions. 230 : 1.

from ordinary low-water mark to two or four meters depth on moles and boulders in Skagerak, the northern Kattegat and the Limfjord, and it does not avoid exposed places. In summer, a narrow belt of dead *Corallina* may be found at low-water mark when the upper part of the *Corallina*-association has been exposed to the air during a long period of low-water. It can also occur abundantly and form associations in deeper water, on gravelly or stony bottom, e. g. in the eastern Kattegat, but it is then frequently associated with *Lithothamnium*. In the sublittoral region it descends frequently to 19 meters depth, but it has been met with at a depth of 29 meters in the northern Kattegat. As to the vegetative development of the frond during the year I have no personal observations, but it must be supposed that the growth begins in the last part of the winter and ceases in summer, and that old fronds are thrown off in autumn. NELSON and DUNCAN (Histology of cert. spec. of Corallinaceæ. Trans. Linn. Soc. Bot. Ser. 2 Vol. I. 1876 p. 203) indicate that there is not much carbonate of lime in the frond in spring. Old fronds are often corroded by various organisms. Ripe tetrasporangia were repeatedly met with in the months of May to July, unripe in March. Ripe antheridia were found in May, ripe cystocarpia in May and December.

Localities. **Ns**: ZQ, jyske Rev, 24.5 m; groin at Thyborøn; Klitmøller, 2 m. — **Sk**: Hanstholm, various places, 4—15 m; YM, YN, Bragerne, 1—10 m; Bulbjerg and Svinkløv, washed ashore; SZ, Løkken, ZK¹, ZK⁷, Lønstrup; Hirshals, mole and boulders near land, and 2 miles N.W. of Hirshals, 11 m; Højen, c. 5 m. — **Lf**: Lemvig; Ydre Røn by Lemvig; ZY; Oddesund; MD; MF, MG, MH, Thisted in Thisted Bredning; harbour of Struer; I; various places in Sallingsund; LS¹; MI; Ejerslev Røn; Holmtunge Hage; Amtøft Rev; LQ. — **Ku**: Harbour of Skagen; KC, TV, Krageskovs Rev; Hirsholmene; Kølpen; Deget; Frederikshavn; Marens Rev, Borrebjergs Rev; Nordre Rønner; TJ; TL; TH; UC; UB; ZL; Jegens Odde; Trindelen; FF, FE; IX; ZB, 29 m; TG. — **Ke**: IM, VY, IP, Fladen; XA, Lille Middelgrund; EU, ET, II, IK, f. *robusta*, dominant, at 14 meters depth. Store Middelgrund: ID, (f. *robusta*, 19 m), IB, HX, IA, 11—19 m; OO, Søborg Hoved Grund, 8.5 m. — **Km**: XF, Læsø Rende; ZC, Kobbergrund; XB; XD; XC; TS; bK; FM; FN (f. *robusta*); ND. — **Ks**: Pakhusbugt, Anholt (loose); EM and EJ, Lysegrund; HS, Briseis Grund; OS, Hastens Grund; OU, Schultz's Grund; D, Grønne Revle north of Isefjord; aU, off Lumsaa; GF, Sjællands Rev; FO, off Havknudd; NB; FP, Jessens Grund. — **Sa**: MZ; KK and KJ, south of Hjelm; KM; BE and BF, off Sletterhage, f. *robusta*, 10 m; MY; PL; Begtrup Vig; Kalø Rev; harbour of Aarhus; PK; FS, Vejre Sund N.E. of Samsø (f. *robusta*); MP; DK, Bolsaxen (f. *robusta*, 14 m); MQ; AH¹; Korshavn; Hofmansgave (Car. Rosenberg); NZ; PK, Norsminde Flak; BC; aX, south Side of Endelave; AI¹ and DJ, by Æbelø; FY, off Bjørnsknude, 5.5 m. — **Lb**: Only found at the harbour of Bogense and at FZ, Kasser Odde, the north side of the reef, 6.5 m. Never met with in the neighbourhood of Middelfart and Fænø, where numerous dredgings have been made. — **Sb**: Harbour of Kerteminde; NR, at the entrance to the harbour of Korsør, only 1.5 m high, on stones picked up in the belt (Nyborg). — In the German part of the western Baltic Sea REINKE records the species from the isle of Als and from Neukirchner Grund in Flensborg Fjord. At Kullen on the west coast of Sweden I have not met with it.

2. *Corallina rubens* L.

Linné Syst. nat. Ed. 12. Vol. I. p. 1305. Kützing, Tab. phyc. 8. Band, 1858, p. 38, Taf. 80; Solms, Corall., p. 42; Hauck, Meeresalg. p. 278.

Jania rubens Lamour.; Kützing, Phyc. gener., 1843, p. 389, Taf. 79 II; Harvey, Phyc. Brit. pl. 252, 1851; Areschoug, in J. Agardh, Sp. g. o. Vol. II 1852, p. 557; Kny, Bot. Zeit. 1872, p. 350; Thuret, Études phyc. 1878, p. 99, pl. L, LI.

This species is usually classed under the genus *Jania*, established by LAMOUROUX. This genus, however, is, as shown by ARESCHOUG (l. c. p. 554), scarcely different from *Corallina* by other characters than the normally forked frond. Mrs. WEBER has later (Siboga, p. 85) stated that there is also an anatomical difference, the cells of the central tissue in the joints being of almost the same length as those of the genicula, while they are much shorter in the true *Corallina*. I prefer, however, to regard *Jania* as a subgenus of *Corallina*.

The articulated fronds are given off from a small thick crust with lobed outline, resembling that of *C. officinalis* but of smaller size. From the crusts examined by me only a small number of fronds, usually 1—3, were given off. The fronds are connected with the crust by a geniculum which may be rather broad (high) (fig. 198A). The fronds are normally forked, the point of vegetation producing by the ramification no shoot in continuation of the axis, but two diverging equally from its direction. The bifurcations occur in greatly varying frequency, the number of interjacent joints varying from 1 to 10 or more. The planes of ramification of the successive bifurcations do not coincide, but cross each other under various angles (comp. KNY, 1872 p. 707). In most of the Danish specimens this is the only ramification existing; but pinnate ramification may also occur. A greater or smaller number of the joints may be complanated, obsagittate and bearing on the upwardly directed points two opposed simple articulated pinnulæ consisting of a small number of joints. When these pinnulæ are produced in a greater number, on several successive joints, we have the f. *corniculata*, which has been regarded as a distinct species, but which cannot be kept distinct from the typical species. The joints at the base of the bifurcations may also bear pinnulæ, under the forking branches. The pinnulæ, no doubt, usually arise later than the branches of the bifurcations, and may then perhaps be regarded as adventitious organs; but it seems that opposite lateral pinnulæ or pinnæ may sometimes arise at the growing point, for according to KNY (l. c. sp. 707) "trichotomies" may also occur. This must take place when the ramification is pinnate. In such cases the middlemost shoot certainly represents the continuation of the axis, and the two lateral ones correspond to the branches of an ordinary bifurcation; I have not, however, examined such ramifications. In rare cases the lateral shoots showed a more vigorous development, and were bifurcate as the ordinary shoots. Supernumerary adventitious pinnulæ may

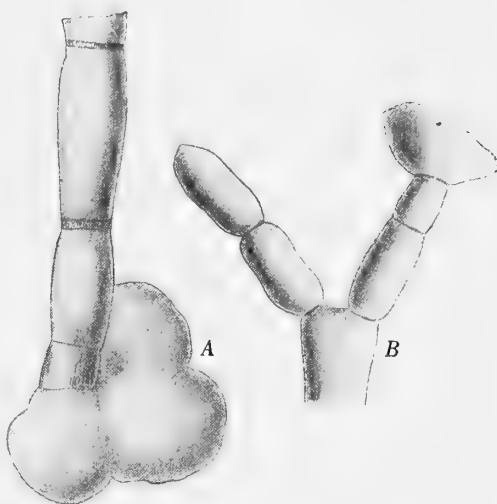


Fig. 198.

Corallina rubens. A, basal part of an articulated frond springing off from the basal disc. B, adhesive disc developed at the end of a branch. 65:1.

sometimes occur under the normal ones. — Hyaline unicellular hairs covering the surface of the frond have been mentioned and figured by THURET (Ét. phyc. p. 96, pl. L, LI, fig. 1, 9, 15, 18). Their occurrence seems to be dependent upon the season, as I found them in specimens collected in July while they were wanting in specimens from August.

The cortical layer consists of two or three cell-layers. It is covered by a continuous layer of low cover cells. The cells of the central tissue are, as mentioned above, almost of the same length as those of the genicula (fig. 199). Lateral fusions take place between the cells of the cortical layer and of the central tissue as well.

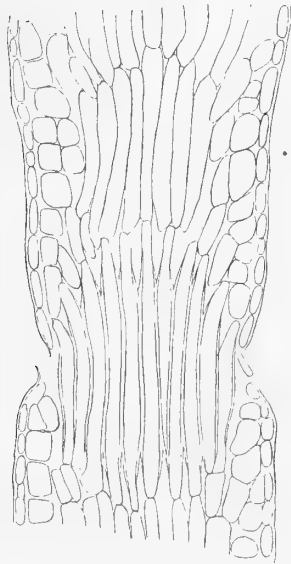


Fig. 199.
Corallina rubens, longitudinal
section of joint. 350:1.

Adhesive discs are not seldom produced at the end of branches which accidentally come in contact with any solid body, e. g. an Alga or a shell of a bivalve. They are, as in *Cor. officinalis*, connected with the frond by a geniculum (fig. 198 B).

As to the organs of reproduction and the germination, reference may be made to the splendid work of THURET (l. c. p. 99, plates L, LI); it should only be mentioned that there are but two kinds of individuals, the sexual plants being monoecious. In the Danish waters only tetrasporangia-bearing plants were found.

The species has been met with in several places at the shore of the Skagerak and in the northern Kattegat. In the Skagerak it occurred partly as *f. corniculata* or a transitional form; in Kattegat it occurred only as *f. typica*. It was found growing on several Algæ, in particular *Ahnfeltia plicata*, further *Chondrus crispus*, *Phyllophora rubens*, *Delesseria* and *Corallina rubens*. It grows partly in small depth, about 1 meter, near the coast, partly deeper, up to 23,5 m depth. It reaches a length of 2—3 cm or a little more. It has been met with both in summer and winter, with ripe tetrasporangia in June to August.

Localities. **Sk:** YM¹, Bragerne, 1—2 m; Lønstrup, washed ashore, partly *f. corniculata*, (C. H. Ostenfeld); Hirshals, 2 m and washed ashore, partly *f. corniculata*. — **Lf:** ZY, Nissum Bredning, a small specimen between loose Algæ. — **Kn:** Hirsholm, about 2 m; N.E. of Hirsholm, c. 7 m (C. H. Ostenfeld); Deget; GM, Engelskmands Banke, 6 m; TP, Tønneberg Banke, 15,5 m; FF, Trindelen, 15 m; TR, near Trindelen, 23,5 m; UB, east of Nordre Rønner; TL and ZL¹ E. of Nordre Rønner.

Fam. 10. Gloiosiphoniaceæ.

Gloiosiphonia Carmichael.

1. *Gloiosiphonia capillaris* Huds. (Carm.)

Carmichael in Berkeley, Gleanings of British Algæ, 1833, p. 45, Tab. 17 fig. 3; Harvey, Phyc. Brit. plate 57, 1846; J. Agardh, Spec., II, p. 161, 1851; Flora Danica, tab. 2574, 1852; Ekman, Bidrag till känned.

af Skand. hafsalger. Stockh. 1857, p. 8; Nägeli, Morph. u. Syst. d. Ceram., Sitzber. Münch. Akad. 1861, II, p. 387; J. Areschoug, Observ. phycol. III, Upsal. 1875, p. 10, Tab. I, fig. 4; Bornet et Thuret, Notes algologiques, I, 1876, p. 41, pl. 13; Schmitz, Untersuch. Befr. Florid., Berlin 1883, p. 224, 230, etc., Taf. V fig. 8–15; Oltmanns, Z. Entwickl. d. Florid., Botan. Zeit. 1898, p. 109, Taf. V; Oltmanns, Morph. u. Biol. d. Algen I, 1904, p. 572, 698; Kolderup Rosenvinge, Hyaline unicell. hairs, Biol. Arb. til. E. Warming, 1911, p. 205, fig. 1–2.

Fucus capillaris Hudson, Fl. Angl. 1762, p. 591.

Gigartina lubrica Lyngbye, Hydroph., p. 45, Tab. 12 A (teste specim.).

The structure of the frond has been described by NÄGELI (1861), BORNET and THURET (1876) and OLTMANNS (1904); reference may be made to the quoted works. The outer cells of the frond contain narrow branched chromatophores; the number of the latter could not be determined. The Danish specimens, collected in June to August, were always provided with numerous hyaline hairs, at least on the young parts of the frond, but sometimes also on the older parts (comp. KOLDERUP ROSENVINGE l. c.). Strange to say, they have not been mentioned and figured by BORNET (l. c.) who examined plants collected at St. Malo in June. On the other hand, KUCKUCK has found hairs terminal on the erect filaments given off from the germ-disc (fig. 356 in OLTMANN'S Morph., p. 572).

As shown by KUCKUCK in the figure quoted, several fronds are given off from a monostromatic basal disc bearing on its upper face numerous short simple or slightly branched cell-filaments. The fronds arise by transformation of some of these filaments; one of the fronds shown in the figure mentioned arises from a branch of a cell-filament. The fronds are divided by transversal walls in low segments, early producing verticillate branches, and afterwards dividing by vertical walls. — The earlier stages of development have been studied in July 1914 at Hirshals, where the carpospores were brought to germinate (fig. 200). The globular spores after having been fixed to the substratum, e. g. a slide or a cover-glass, surround themselves with a membrane, and frequently show the first signs of germination within 24 hours, a germinating tube being produced at one side and separated from it by a wall. The circular spore-body is frequently divided by a wall, the orientation of which to the germinating tube is not constant. After 2 days the germinating filament was 3–4 times as long as the spore-body, usually two-celled, the ultimate cell being densely filled with protoplasm, while the undermost were almost empty, and the spore-cell as well. Sometimes two germinating tubes are given off from the same spore, either diametrically opposed or diverging under an obtuse angle. After four days the first germinating spores had produced long germinating filaments which

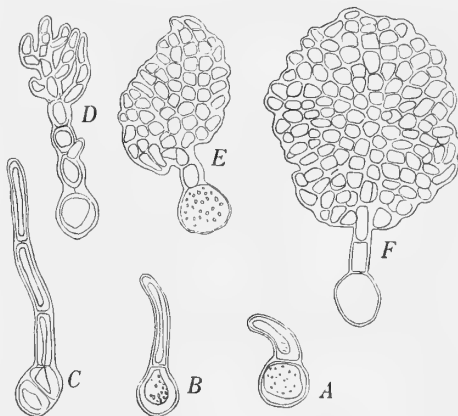


Fig. 200.

Gloiosiphonia capillaris. Sporelings. A and B two days old, C three days, D 6 days, E 10 days and F 29 days old. 350:1.

commenced to branch, producing usually alternating branches at their distal end. The following day a great number of the sporelings had produced a multicellular monostromatic disc arising by further branching and fusing together of the branches, and being terminal on a shorter or longer filament. After ten days the germ discs were larger, some of the cells were divided by transversal walls, and several hairs were given off from the upper surface. Some sporelings continued growing as long unbranched filaments, but producing no disc; they were growing obliquely upwards against the light. It is probably the want of contact with any solid substratum which has caused the absence of a disc. The cultures were continued during up to a month. The sporelings showed at the end of that time no essential differences; they were only somewhat larger, having increased by marginal growth and cell-



Fig. 201.

Gloiosiphonia capillaris.
Part of transversal section
of frond with antheridia.
670:1.

divisions, and most of the cells were divided by a horizontal wall, which may signify that the upper cell formed may be the mother-cell of a vertical filament as described by KUCKUCK, but these filaments were not yet formed in their definite shape. Numerous hairs were frequently produced by the disc. Fronds emerging from the discs were not observed; they are probably only produced in the following year, the plant wintering probably in the disc-shaped stage. The outline of the discs is nearly orbicular. The number of the cells in the basal germ filament is rather variable; usually it is small, and the filament may be wanting, the branches continuing to the spore-cell. — A similar formation of the germ disc, not from the spore-cell but from the germ-tube produced by it, is known also for other Florideæ, e. g. *Dudresnaya* (KILLIAN, Entw. ein. Florid. Zeitschr. f. Botanik. VI, 1914, p. 237).

The antheridia are, as shown by BORNET and THURET (l. c. p. 42) found in spots scattered on the plants which bear the carpogonia. They are oblong or obovate, and are produced by transversal divisions of narrow cells covering the surface of the plant. These cells branch, being divided by oblique walls (fig. 201).

Regarding the development and structure of the cystocarps, reference may be made to the important paper by OLTMANNS in 1898 (see also 1904) where it was proved that the double fertilization, presumed by SCHMITZ for this plant, do not take place.

The tetrasporangia were unknown to J. AGARDH, as late as in 1876 (*Epicrisis* p.115) although they were described by EKMAN in 1856 and by ARESCHOUG in 1875. They are, according to the named authors, cruciately divided, though often very irregularly; the sporangia-bearing specimens are much branched above, bearing dense bushes of branches. Such specimens were found at Christianssund on the west coast of Norway in August, later on the coast of Bohuslän in June by KYLIN. On the Danish shores, sporangia-bearing specimens have never been found. All the specimens examined (nearly 200) were sexual plants.

The species occurs on stones in exposed places in small depths (1—5 meters).

It can support a strong surf and is then living in much polluted water. It attains a length of 15 cm in the Skagerak, 8 cm in the Limfjord. It has only been collected in June to August. Nearly all the specimens bore cystocarpia. It has only been found in the saltiest waters.

Localities. **Sk:** YN, within Bragerne, 5 m; washed ashore on Grønhøj Strand (Miss Ellen Møller); Hirshals, mole and reefs, 1—5 m. — **Lf:** Sallingsund, near Nykøbing, east side of Odden (Th. Mortensen, !) and off Grønnerup. In the herbarium of the Botan. Museum at Copenhagen a specimen is to be found, labelled Limfjorden Aug. 1869, probably collected by J. P. Jacobsen.

Some general remarks on the Cryptonemiales.

1. **Intercalary cell-divisions.** The species belonging to this order appear as a rule to follow with great regularity the rule pointed out by SCHMITZ¹⁾ for cell-division in Florideæ: that only the terminal cells in the filaments, of which the frond is composed, divide by transverse walls. Some cases occur, however, where transverse divisions of the segment cells have been noted. Thus, according to BREBNER, intercalary transverse divisions take place in *Dumontia incrassata* in the short-celled filaments, which grow out from the basal disc and form the upright fronds (see above p. 156). Another instance I have noticed in *Hildenbrandia prototypus*, where intercalary divisions may occur in the radiating filaments forming the basal layer, which makes itself apparent in the fact that the cells are shorter at some distance from the margin than at the margin itself (p. 203 fig. 121). It should further be mentioned, that the filaments in several *Melobesieæ* (*Lithothamnion*, *Corallina*) terminate in a covering cell, which does not divide, and which forms, together with the covering cells of the adjacent filaments, an outer layer, incapable of development, the penultimate cell in the filament taking over the function of the terminal cell as an initial one. A deviation from the order of succession in cell division as noted by SCHMITZ may also be found in some species of *Melobesia* and *Lithophyllum*, where two or more cortical cells, likewise incapable of division, are cut off one below the other at the end of the same mother cell (p. 254 fig. 174 and p. 264 fig. 184 B)²⁾.

2. **Cell-fusions.** Secondary pits, which are commonly found in the Rhodamelaceæ and several other families of the Florideæ³⁾ appear to be altogether lacking in most Cryptonemiales. I have only found them in the genus *Lithophyllum*. As

¹⁾ FR. SCHMITZ, Untersuch. über die Befrucht. d. Florideen. Sitzungsber. d. Ak. d. Wiss. Berlin 1883, p. 216.

²⁾ Intercalary divisions appear to occur throughout the whole of the frond, at any rate in the perithallium in the genus *Porolithon*, to judge from the drawings of Mme LEMOINE in BØRGESSEN, The Marine Algæ of the Danish West Indies, III Rhodophyceæ: Dansk Botanisk Arkiv. II p. 177 and p. 179.

³⁾ Comp. L. KOLDERUP ROSENVINGE, Sur la formation des pores secondaires chez les Polysiphonia. Botan. Tidsskr. 17. Bind. Kjøbenhavn, 1888, p. 10.

mentioned on p. 210, this genus is characterised by the fact that the cells in the upright filaments, of which the frond (the perithallium) is composed, are connected by transverse pits, the origin of which must be of a secondary nature. I have not, however, been able to follow their development, and particularly did not succeed in ascertaining the co-operation of the nuclei in their formation. In the remaining members of the family of Corallinaceæ, on the other hand, there is a different method by which the cells in various filaments may enter into direct communication one with another, to wit, by dissolution of the separating wall, whereby an open connection is established between the cells. This feature has already been referred to above (p. 210) where it was also pointed out that more than two cells may fuse together, and that the cell-fusions may involve fusion of the nuclei (cf. figs. 136, 139, 156 and many others). Only in two of the Danish Corallinaceæ have the fusions hitherto not been shown (*Melobesia minutula* and *Choreonema Thuretii*).

Entirely similar cell-fusions were demonstrated in various Squamariaceæ, viz, *Cruoriopsis danica* (p. 185 fig. 107), *Cruoriopsis gracilis* (p. 188 fig. 111), *Rhododermis elegans* (p. 198 fig. 118) and *Rhododermis Georgii* (p. 199 fig. 119). In *Hildenbrandia*, on the other hand, they were not found.

That cell-fusions are important as facilitating connection between cells and cell-filaments not directly in communication by plasma-continuity can hardly be doubted. We find them also particularly numerous in the "roof" above the conceptacle in the Corallinaceæ, i. e. between cells whose indirect connection below has been interrupted by the formation of the conceptacle. Comparison with *Hildenbrandia*, which lacks cell fusions, supports this view, as the roof of a conceptacle, which grows in extent through the continued sporangia formation, consists of dead and more or less disorganised cells, save at the margin, undoubtedly owing to the fact that the connections below have been interrupted, and those to the sides are wanting (cf. p. 204 and figs. 125, 126.).

3. **Alternation of generations and alternation of nuclear phases.** As we know, there has in several Florideæ been shown to exist a regular alternation between a haplophase, consisting of the sexual generation, and a diplophase, consisting of two generations, viz; the cystocarp or gonimoblast, and the tetraspore-bearing plant¹⁾. A like course of development must be presumed to take place in all Florideæ with normal fertilisation, and having tetrasporangia. SVEDELIUS has called these Florideæ diplobiontic, in contrast to the haplobiontic, which lack tetraspores, and in which the chromosome reduction takes place by division of the zygote nucleus²⁾. Here then, we have but two generations, the sexed plant and the cystocarpium, both

¹⁾ Comp. H. KYLIN, Die Entwick. u. syst. Stell. von *Bonnemaisonia asparagoides* etc. Zeitschr. f. Botanik, 8. Jahrg., 1916, p. 570. — J. BUDER, Zur Frage des Generationswechsels im Pflanzenreiche. Ber. deut. bot. Ges. Bd. 34. 1916, Heft 8. — O. RENNER, Zur Terminologie des pflanzlichen Generationswechsels. Biolog. Centralblatt. Bd. 36, 1916, p. 337.

²⁾ N. SVEDELIUS, Zytolog.-entwicklungsgesch. Stud. über *Scinaia furcellata*. N. Acta reg. soc. sc. Upsal. Ser. IV. vol. 4 no. 4. Upsala 1915, p. 42.

haploid, and the diploid phase is restricted to the undivided zygote cell. To these Florideæ belongs, among the species mentioned in the present paper, *Halarachnion ligulatum*. *Gloiosiphonia capillaris* must also be haplobiontic on the coasts of Denmark, where, as on those of France, tetrasporangia-bearing plants have never been found, though they have been met with on the coasts of Norway and Sweden (see p. 278).

On the other hand, there are species which only propagate by tetraspores, not sexually. This applies first of all to the *Hildenbrandia* species, which are extremely common with tetraspores, but have never been found with sexual organs. In *Cruoriopsis gracilis* also, and *Rhododermis Georgii*, sexual organs are quite unknown. *Rhododermis elegans* again, has always been found with tetrasporangia only, save for the case of some specimens from North-east Greenland, which bore antheridia. There are moreover some Corallinaceæ which have hitherto been found in Danish waters only with tetrasporangia (*Lithothamnion læve, glaciale, Sonderi, norvegicum*, and *lævigatum*). In all these, at any rate those first named, tetraspore formation must be supposed to take place without reduction of the chromosomes.

It should further be noted that in some species, albeit possessing both kinds of spores, the two kinds do not occur with like frequency. This is probably the case with several of the *Lithothamnion* species just referred to, the sexual plants being presumably not altogether lacking, but merely rarer than those bearing tetraspores, and have therefore not hitherto been found. On the other hand, sexed plants of *Polyides rotundus* seem to be far more common than the tetraspore plants in the Danish waters. All this might seem to suggest that these species have no regular alternation of generations, such as takes place in the typical diplobiontic Florideæ, in which sexual plants and those bearing tetraspores are nearly alike in point of frequency.

Parthenogenesis has been shown with certainty in *Platoma Bairdii* by KUCKUCK. In the Little Belt, it appeared in the same manner as at Helgoland, the antheridia lacking, whereas cystocarpia and tetrasporangia were found. Here also the tetrasporangia must be formed without reduction of the chromosomes. Possibly parthenogenesis may also occur in other Cryptonemiales. Some observations would seem to suggest that this may be the case in *Furcellaria fastigiata*. The fact that I did not find the spermatia attached to the trichogynes I do not consider as of great importance; more significant, however, is the finding of an unfertilised carpogonium with a short trichogyne, but which had nevertheless formed an outgrowth which could only be regarded as a sporogenous filament (cf. p. 169, fig. 85 D). — In *Petrocelis Henedyi* I found, in some instances, sporogenous filaments growing out from carpogonia which showed no interruption of the plasmatic connection with the trichogyne (fig. 98 E, 99 E) and here also, no spermatia were found attached to the trichogynes.

Finally, some cases have been noted where tetraspores and sexual organs appeared in one and the same individual. This has occasionally been found in

Petrocelis Hennedyi and *Cruoria pellita*. Here also it must be presumed that the tetrasporangia are formed without reduction of chromosomes.

There are thus a considerable number of Cryptonemiales which differ with regard to the course of development from the typical diplobiontic forms.

SVEDELIUS¹⁾, referring to the simultaneous occurrence of monospores and tetraspores in one and the same individual of *Chantransia efflorescens*, considers it not altogether impossible that future investigation of the cruciate tetrasporangia may show them to have been produced without reduction of chromosomes. Up to the present, however, no Floridea with such sporangia has been subjected to closer cytological investigation. The Swedish writer points out in this connection, that such sporangia are first divided by a transverse wall, and thereafter by two perpendicular partitions, which he considers would hardly fit in with a reduction division. It should nevertheless be borne in mind that we find, both in Archegoniates and in flowering plants, cruciate sporangia as well as zonate sporangia, — though the latter, it is true, are more rare — and it seems not to be apparent that the formation of a cell-wall on the first division would preclude the reduction of chromosomes. As regards the zonate division, it has in several of the Corallinaceæ been demonstrated with certainty that the three cell-divisions take place almost simultaneously, and that the nuclear divisions are completed before the cell-division sets in (see p. 273). It is hardly likely that there should be any difference in principle between the cruciate and the zonate division; among other reasons, because we find both occurring in the species of the genus *Hildenbrandia*, — which are doubtless very closely related — where the sporangia must also be presumed to divide without reduction of chromosomes (cf. also *Lithothamnion Sonderi*, fig. 137). If SVEDELIUS' supposition were correct, it would involve either that the reduction division must take place by the division of the zygote nucleus, in spite of the presence of tetrasporangia, or that it never occurred among Cryptonemiales, since the tetrasporangia, as far as we know, here never divide tetrahedrally, but always by parallel or cruciate walls, often markedly inclined. The latter alternative would further imply that the cystocarpia were throughout developed by parthenogenesis, which is not in accordance with the actual facts, as, though fertilization has not, it is true, been cytologically demonstrated in any of these algæ, which are furnished with tetraspores²⁾, yet spermatia have at any rate been found attached to the trichogynes in *Dumontia incrassata* (see above p. 158), *Polyides rotundus* (THURET, Et. phyc. Pl. 38 figs. 14—18) and in certain Corallinaceæ (*Choreonema Thuretii*, SOLMS, Corall. Taf. III, fig. 4, *Corallina mediterranea*, SOLMS, l. c. Taf. III, fig. 19).

On the other hand, it must be presumed that reduction division may also be lacking in tetrahedrally divided sporangia, as cases are also known where such

¹⁾ N. SVEDELIUS, l. c. p. 50.

²⁾ The fertilization has been cytologically demonstrated in *Gloiosiphonia capillaris* by OLTMANN; but this Alga has usually no tetrasporangia.

sporangia occur in the same plant as sexual organs, (e. g. *Callithamnion corymbosum*, cf. THURET in LE JOLIS' Liste d. Alg. mar. de Cherbourg, p. 112).

As will be seen from the above, there are many features in the Cryptonemiales which call for further cytological investigation, especially with regard to the presence of a fertilisation process and the manner in which nuclear division takes place in the tetrasporangia. The latter point will doubtless be the easier to decide, as the tetrasporangia are in many species easily found, and contain large nuclei.

EXPLANATION OF PLATES.

Plate III.

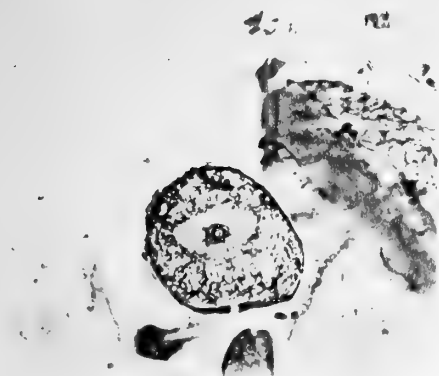
All the figures are microphotographs after microtome-sections taken by Mr. A. HESSELBO.

1. *Lithothamnion læve* Strömf. Tetraspore (dispore), showing the nucleus with nucleolus (fallen out) and the structure of the protoplasm. (Specimen from Aalsgaarde). About 225:1.
2. *Lithothamnion Lenormandi* (Aresch.) Foslie. Vertical section of antheridial conceptacle. (Specimen from TF¹). About 200:1.
3. *Lithothamnion Lenormandi* (Aresch.) Foslie. Vertical section of conceptacle of cystocarp. (Specimen from XQ). About 200:1.
4. *Lithothamnion glaciale* Kjellm. f. *Granii* Fosl. Section of crustaceous frond with conceptacles of sporangia. (Specimen from Læsø Rende). About 180:1.
5. *Lithothamnion polymorphum* (L.) Aresch. Vertical section of female conceptacle showing procarps. (Specimen from Store Middelgrund, May).
6. *Lithothamnion polymorphum* (L.) Aresch. Vertical section of emptied conceptacles of sporangia with covering tissue. (Specimen from reef near Korsør).

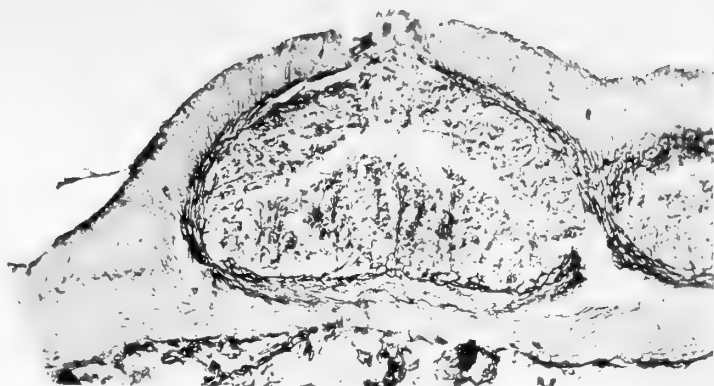
Plate IV.

All figures from photographs in natural size.

- 1—4. *Lithothamnion glaciale* Kjellm. f. *Granii* Fosl. 1 and 2 attached to stones, 3 free, 4 similar one being on the point of dividing. (Specimens from IH, 3375).
- 5—6. *Corallina officinalis* L., f. *robusta* Kjellm. (Specimen from YU, Hanstholm. 7286). In fig. 5 the branchlets are partly verticillate.
7. *Corallina officinalis* L., slender, slightly branched form with some stoloniform branches growing out in a transversal direction. (Specimen from UC, north of Læsø, 5625).
8. *Corallina officinalis* L. f. *robusta* Kjellm. With lateral conceptacles. (Specimen from MZ, 4058).



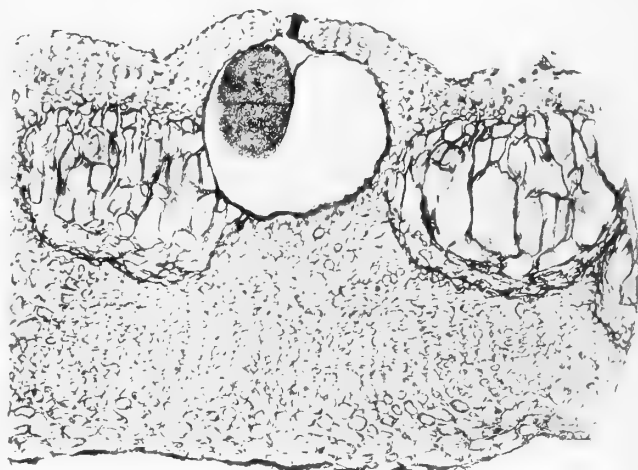
1



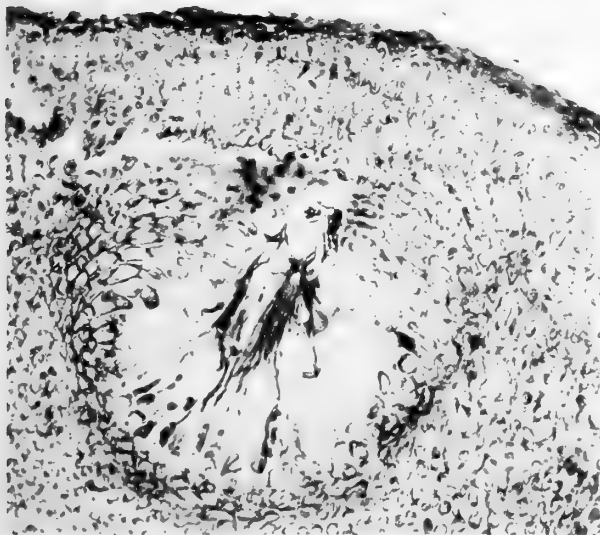
2



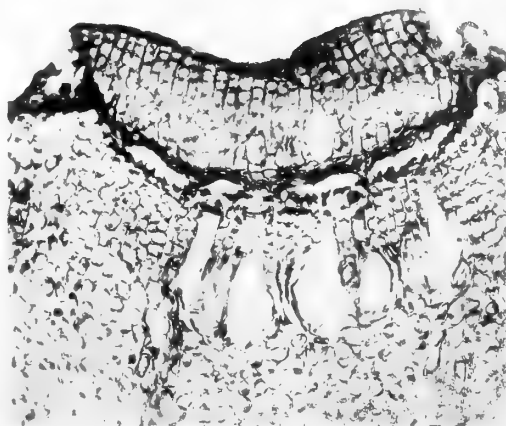
3



4



5



6



	Kr.	Øre
VI, med 4 Tavler. 1890—92	13.	75.
1. Lorenz, L. Lysbevægelsen i og uden for en af plane Lysbølger belyst Kugle. 1890	2.	"
2. Sørensen, William. Om Forbeninger i Svømmeblæren, Pleura og Aortas Væg og Sømmensmeltningen deraf med Hvirvelsøjlen særlig hos Siluroiderne, samt de saakaldte Weberske Knoglers Morfologi. Med 3 Tavler. Résumé en français. 1890	3.	80.
3. Warming, Eug. Lagoa Santa. Et Bidrag til den biologiske Plantegeografi. Med en Fortegnelse over Lagoa Santas Hvirveldyr. Med 43 Illustrationer i Texten og 1 Tavle. Résumé en français. 1892	10.	85.
VII, med 4 Tavler. 1890—94	13.	75.
1. Gram, J. P. Studier over nogle numeriske Funktioner. Résumé en français. 1890	1.	10.
2. Prytz, K. Metoder til korte Tiders, særlig Rotationstiders, Udmaaling. En experimental Undersøgelse. Med 16 Figurer i Texten. 1890	1.	50.
3. Petersen, Emil. Om nogle Grundstoffers allotrope Tilstandsformer. 1891	1.	60.
4. Warming, Eug. Familien Podostemaceae. 4 ^{de} Afhandling. Med c. 185 mest af Forfatteren tegnede Figurer i 34 Grupper. Résumé et explication des figures en français. 1891	1.	50.
5. Christensen, Odin T. Rhodanchromammioniakforbindelser. (Bidrag til Chromammioniakforbindelsernes Kemi. III.) 1891	1.	25.
6. Lütken, Chr. Spolia Atlantica. Scopelini Musei Zoologici Universitatis Hauniensis. Bidrag til Kundskab om det aabne Havs Laxesild eller Scopeliner. Med 3 Tavler. Résumé en français. 1892	3.	50.
7. Petersen, Emil. Om den elektrolytiske Dissociationsvarme af nogle Syrer. 1892	1.	25.
8. Petersen, O. G. Bidrag til Scitamineernes Anatomi. Résumé en français. 1893	2.	75.
9. Lütken, Chr. Andet Tillæg til «Bidrag til Kundskab om Arterne af Slægten <i>Cyamus</i> Latr. eller Hval-lusene». Med 1 Tavle. Résumé en français. 1893	"	85.
10. Petersen, Emil. Reaktionshastigheden ved Methylætherdannelsen. 1894	1.	50.
VIII, med 3 Tavler. 1895—98	12.	25.
1. Melnert, F. Sideorganerne hos Scarabæ-Larverne. Les organes latéraux des larves des Scarabés. Med 3 Tavler. Résumé et explication des planches en français. 1895	3.	30.
2. Petersen, Emil. Damptryksformindskelsen af Methylalkohol. 1896	1.	"
3. Buchwaldt, F. En mathematisk Undersøgelse af, hvorvidt Vædsker og deres Dampe kunne have en fælles Tilstandsligning, baseret paa en kortfattet Fremstilling af Varmetheoriens Hovedsætninger. Résumé en français. 1896	2.	25.
4. Warming, Eug. Halofyt-Studier. 1897	3.	"
5. Johannsen, W. Studier over Planternes periodiske Livsyttringer. I. Om antagonistiske Virksomheder i Stofskiftet, særlig under Modning og Hvile. 1897	3.	75.
6. Nielsen, N. Undersøgelser over reciproke Potenssummer og deres Anvendelse paa Rækker og Integraler. 1898	1.	60.
IX, med 17 Tavler. 1898—1901	17.	"
1. Steenstrup, Japetus, og Lütken, Chr. Spolia Atlantica. Bidrag til Kundskab om Klump- eller Maanefiskene (<i>Molidæ</i>). Med 4 Tavler og en Del Xylografer og Fotogravurer. 1898	4.	75.
2. Warming, Eug. Familien Podostemaceae. 5 ^{te} Afhandling. Med 42 Figurgrupper. Résumé en français. 1899	1.	60.
3. Meyer, Kirstine. Om overensstemmende Tilstande hos Stofferne. En med Videnskabernes Selskabs Guldmedaille belønnet Prisaafhandling. Med en Tavle. 1899	2.	60.
4. Jørgensen, S. M. Om Zeise's Platosemiæthylen- og Cossa's Platosemiamminsalte. Med 1 Tavle. 1900	"	75.
5. Christensen, A. Om Overbromider af Chinaalkaloider. 1900	1.	"
6. Steenstrup, Japetus. Heteroteuthis Gray, med Bemærkninger om Rossia-Sepiola-Familien i Almindelighed. Med en Tavle. 1900	"	90.
7. Gram, Bille. Om Proteinkornene hos oliegivende Frø. Med 4 Tavler. Résumé en français. 1901	2.	50.
8. Melnert, Fr. Vandkalvelarverne (<i>Larvæ Dytsiscidarum</i>). Med 6 Tavler. Résumé en français. 1901	5.	35.
X, med 4 Tavler. 1899—1902	10.	50.
1. Juel, C. Indledning i Læren om de grafiske Kurver. Résumé en français. 1899	2.	80.
2. Billmann, Einar. Bidrag til de organiske Kvægsølvforbindelsernes Kemi. 1901	1.	80.
3. Samsoe Lund og Rostrop, E. Marktidsele (<i>Cirsium arvense</i>). En Monografi. Med 4 Tavler. Résumé en français. 1901	6.	"
4. Christensen, A. Om Bromderivater af Chinaalkaloiderne og om de gennem disse dannede brintfattigere Forbindelser. 1902	1.	40.
XI, med 10 Tavler og 1 Kort. 1901—03	15.	05.
1. Warming, Eug. Familien Podostemaceae. 6 ^{te} Afhandling. Med 47 Figurgrupper. Résumé en français. 1901	2.	15.
2. Ravn, J. P. J. Molluskerne i Danmarks Kridtaflejringer. I. Lamellibranchiater. Med 1 Kort og 4 Tavler. 1902	4.	"
3. Winther, Chr. Rotationsdispersionen hos de spontant aktive Stoffer. 1902	2.	"
4. Ravn, J. P. J. Molluskerne i Danmarks Kridtaflejringer. II. Scaphopoder, Gastropoder og Cephalopoder. Med 5 Tavler. 1902	3.	40.
5. Winther, Chr. Polarimetriske Undersøgelser II: Rotationsdispersionen i Opløsninger	1.	60.
6. Ravn, J. P. J. Molluskerne i Danmarks Kridtaflejringer. III. Stratigrafiske Undersøgelser. Med 1 Tavle. Résumé en français. 1903	3.	85.
XII, med 3 Tavler og 1 Kort. 1902—04	10.	50.
1. Forch, Carl, Knudsen, Martin, og Sørensen, S. P. L. Berichte über die Konstantenbestimmungen zur Aufstellung der hydrographischen Tabellen. Gesammelt von Martin Knudsen. 1902	4.	75.
2. Bergh, R. Gasteropoda opisthobranchiata. With three plates and a map. (The Danish expedition to Siam 1899—1900. I.) 1902	3.	45.
3. Petersen, C. G. Joh., Jensen, Søren, Johansen, A. C., og Levinson, J. Chr. L. De danske Faryandes Plankton i Aarene 1898—1901. 1903	3.	25.
4. Christensen, A. Om Chinaalkaloidernes Dibromadditionsprodukter og om Forbindelser af Alkaloidernes Chlorhydrater med højere Metalchlorider. 1904	1.	35.

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Warming, Eug. Forgreningsforhold hos Fanerogamerne, betragtede med særligt Hensyn til Kløvning af Væxtpunktet, m. 11 Tavler og mange Træsnit. Résumé en français. 72	6. 45
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— Om en særegen Udvikling hos visse Snyltesvampe, navnlig om den genetiske Forbindelse mellem Sevenbommens Bævrerust og Pæretræets Gitterrust, m. 3 Tavler. 68.....	1. 25
— Bidrag til Kundskab om Egefamilien i Fortid og Nutid, m. 8 Tavler og 1 Kort, Résumé en français. 71. 6. •	

